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EVALUATING THE ENVIRONMENTAL HEALTH WORK FORCE

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HEALTH & HUMAN SERVICES
Public Health Service
Health Resources and Services Administration

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EVALUATING THE ENVIRONMENTAL HEALTH WORK FORCE

Prepared by:
Levine Associates, Inc.
Rockville, Maryland 20852
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Copies of this report and its reference materials may be obtained by writing to the Government Project Officer:

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EXECUTIVE SUMMARY

Concern with environmental impacts on health has grown in recent years. Since the late 1960's, numerous governmental programs have been adopted to address environmental problems related to air, water, milk and food, radiation, occupational safety and health, noise and hazardous materials. At the Federal level, new environmental health agencies have been established, such as the National Institute for Occupational Safety and Health, National Institute of Environmental Health Sciences and the Environmental Protection Agency, to join long established agencies of the Public Health Service like the Food and Drug Administration in coping with public concerns in the area. Legislation such as the Clean Air Act, Safe Drinking Water Act and Superfund have been passed. All of this activity has created a substantial demand for additional environmental health personnel.

The growing importance of environmental health is underscored by the health objectives stemming from the Surgeon General's 1979 Report on Health Promotion and Disease Prevention. Of the 226 objectives delineated to fulfill the purposes of that Report by 1990, 57 (25 percent) are in the areas of toxic agent and radiation control, occupational safety and health, and accident prevention and injury control. A recently issued Midcourse Review of progress toward attaining the health objectives showed that much more needs to be done. For example, of the 20 objectives in toxic agent and radiation control, none has yet been achieved. Four are on track to be met by 1990 and there are no data to track progress on the remaining 16. Among the important objectives related to environmental health are the reduction in lead toxicity in children, prevention of birth defects and miscarriages due to exposure to toxic substances, the reduction of work-related injuries or death, and the reduction of the home injury fatality rate.

In order to achieve these key health objectives and evaluate the impact of various environmental insults and implement legislation, large numbers of highly trained environmental health professionals are required. It is extremely important to know how many of these health professionals currently exist, the adequacy of this supply in relation to demand and need, and what future demand and need are likely to be. Currently, little comprehensive and accurate data with which to evaluate the environmental health work force exist. The supply of environmental health personnel has been variously estimated at between 25,000 and 600,000 depending on how the work force is defined and measured. Reports to the Congress in recent years on the status of health personnel have emphasized this lack of data and noted that this makes sensible planning of educational programs very difficult.

To help close the information gap on the environmental health work force, the Health Resources and Services Administration's Bureau of Health Professions contracted with Levine Associates, Inc. to quantitatively and qualitatively evaluate environmental health personnel supply, demand and need and to make recommendations concerning the means by which deficiencies could best be corrected. The methodology for this evaluation was to: (1) develop a taxonomy of the major environmental health specialties; (2) develop resource materials including a compilation of existing studies; (3) commission background papers on the status of the work force in each specialty area; and, (4) convene fifty of the leading experts in the nation in a workshop at Airlie House in Warrenton, Virginia on July 13-16, 1987. A compilation of previous studies of the work force, the background papers, and the experts' collective knowledge and expertise were used as resource materials in making estimates.

The workshop participants represented a broad spectrum of environmental health areas and all levels of government, private industry, academia and professional associations. They were organized into five groups according to the similarity of their specialties to arrive at a consensus on supply, demand and need for each specialty area. The five groups addressed the following areas:

- Air and Water Quality
- Milk & Food Protection and Institutional Safety & Health
- Hazardous Materials Management and Epidemiology, Toxicology & Risk Assessment
- Occupational Safety & Health and Radiological Health
- Land Use Planning & Management, Solid Waste Management, Housing, Vector Control, Injury Control, and Consumer Protection & Safety

Following the workshop, the participants in academia developed estimates of the supply, demand and need for faculty in environmental health using the results of the five groups' position papers.

The workshop and the work performed in preparing background materials and in synthesizing the various commissioned papers and group reports after the workshop fills a void in a most important area: environmental health personnel information. The workshop report is unique and important as the first attempt to comprehensively analyze the environmental health work force in its entirety from the standpoint of supply, demand and need.

According to available data and estimates made by the workshop participants, there are approximately 715,000 persons employed in professional and technical positions in the environmental health work force in 1987. Only 80,000, or about 11 percent, have formal education in environmental health and can be called environmental health professionals. Another 155,000 (22 percent) are professionals with relevant skills such as engineers and chemists who are currently conducting environmental health activities but who have no training in public health. The remaining 480,000 members of the work force , two-thirds of the total, are technicians or operators who are not academically trained in programs leading to at least a baccalaureate degree. There are additional needs today for 121,000 professionals in the various environmental health specialty areas.

In addition to large quantitative needs for more environmental health specialists, the experts found that a large portion of the present work force is inadequately trained. Workshop participants estimated that approximately 40,000 members, or 17 percent, of the professional work force is inadequately trained. Many individuals currently in the work force do not meet the minimum educational, experience or certification requirements identified by workshop participants, including occupational health nurses and physicians, hazardous materials managers, institutional environmental health practitioners, and others. Further, due to rapid change in technical areas and program priorities, the skills and knowledge of current practitioners urgently need to be upgraded.

The majority of environmental programs involve the administration of environmental laws or relate to cleaning up the environment. Thus, a large proportion of environmental health personnel are employed in government agencies at the Federal, state and local levels. Practitioners are also employed by industry, educational institutions, consulting firms and others in the private sector. Thus, all sectors of society need to be concerned with work force problems in environmental health. These problems are found in a wide array of specialities including wastewater personnel, milk and food sanitarians, institutional environmental health managers, environmental epidemiologists, environmental toxicologists, hazardous waste managers, industrial hygienists, occupational health nurses, occupational health physicians, solid waste managers, and environmental health professionals in housing, vector control and injury control. Shortages are particularly acute in the area of hazardous materials management because of a large need for these professionals, the diversity of skills required, and the necessity to maintain a high level of competence.

The workshop participants also made projections of environmental health work force supply, demand and needs to 1992. The work force supply is expected to grow at a rate of about two percent per year, with some small gains in overall quality and quantity in relation to need. In five years shortages will still remain. Most employees will continue to be professionals from other fields, rather than environmental health professionals.

While the private sector plays a very important role, protection of the environment is primarily the responsibility of the various levels of government. Therefore, solving the work force problems identified by the workshop participants should be a governmental priority. According to the participants, if we are to clean-up our water supply, our indoor and outdoor air supply, and our hazardous waste sites, protect our food supply, and, prevent injuries in homes and at the work site, there must be a national plan. The experts believed that government has failed to provide the leadership that it should for such planning or for developing the supply of properly trained personnel that is essential for effective and comprehensive environmental program management.

The Public Health Service should take the lead in developing such a plan to delineate the necessary training and education of the work force in order to provide needed services efficiently and effectively. The Public Health Service should work closely with the Environmental Protection Agency and other Federal agencies in the development of a plan addressing education and training of personnel in both formal and informal modes, including bachelors, masters and doctoral degree programs, associate degree programs, continuing professional education programs, and seminars, and self-teaching and extension courses. The plan should also address the retraining of personnel for service in new and emerging areas of environmental health, such as risk assessment. Working together on such a plan would help bring the Public Health Service and the Environmental Protection Agency closer in developing strategies and programs to meet work force needs.

Participants at the workshop felt that it was essential that these educational vehicles elicit Federal support. It was suggested that a percentage of funding support for each major environmental law should be set aside for this purpose. In addition, to implement a national plan successfully, all levels of government must establish a process whereby education and training would be available to personnel who are implementing Federal laws and regulations affecting health, safety and the environment.

Specific recommendations concerning training, education, credentialing and the utilization of personnel include:

- Increase Federal support of basic (e.g., collegiate) education programs in environmental health.
- Provide funds to upgrade the professional skills and knowledge of individuals in technical positions.
- Develop role delineation models for the major environmental health specialties (as guides to curriculum design and credentialing).
- Develop basic or core curricula for the various specialties in environmental health.
- Place more emphasis on graduate training including the preparation of academicians.
- Establish credentialing (education program accreditation and practitioner certification) policies and procedures.
- Develop effective continuing education systems.
- Explore the cross-training of other health professionals in the fundamentals of environmental health.
- Develop innovative solutions to work force problems such as a Food Protection Academy modeled after the FBI Academy.

Finally, the experts addressed the severe gaps in data that make work force evaluation and planning extremely difficult. The following recommendations were made concerning these gaps:

- Reliable data about the actual qualifications of individuals who now serve in environmental health positions must be assembled.
- Reliable data about educational opportunities in environmental health must be obtained.
- Federal funding should be provided for a comprehensive survey of the current environmental health work force.
- Environmental health work force measurement and analysis funding should be obtained by the transfer of a small percentage of service funds (for example, one percent of the Superfund) to this activity.

ACKNOWLEDGMENTS

This project was developed and monitored within the Bureau of Health Profession's Public Health Professions Branch, Dr. William S. Brooks, Chief. Much credit goes to the government Project Officer, Mr. Barry Stern, for calling attention to this major gap in information and for providing guidance and direction for the evaluation. Mr. Jerry McClendon, Deputy Chief, Public Health Professions Branch, provided valuable assistance throughout the project, but especially in the compilation of the numerical estimates and the overall understanding of supply/demand/and needs methodology.

The project was conducted by Levine Associates, Inc. with Dr. Daniel Levine as Officer-in-Charge. Dr. Eugene Levine directed the project and served as the moderator for the workshop. Ms. Donna Mahoney coordinated the workshop logistics and prepared the summaries of commissioned papers and workgroup reports that appear in this report. The background material was assembled by Mr. Bradford Koles and the extensive typing that was required by this project was done by Ms. Kerry Armstrong. Finally, valuable advice was received by Mr. Larry Gordon and Dr. Larry Krone who served as project consultants and, together with Mr. Stern and Mr. McClendon, provided Levine Associates with considerable guidance and support in carrying out this interesting and stimulating project.

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1. OVERVIEW AND SYNTHESIS

This report contains all materials pertinent to an intensive evaluation of the environmental health work force conducted in 1986 and 1987. A workshop was one of the key tools used in conducting this study. The workshop brought together approximately 50 experts in the various areas of environmental health, from academia, government agencies, private industry, and professional associations to make estimates of environmental health personnel supply, demand and need. Previous estimates of these environmental health work force parameters were very limited and imprecise. Thus, considering the increasing concern over environmental issues in recent years, this study meets an important need.

This study's workshop represented the culmination of a very intensive prior effort by Levine Associates and the staff of Bureau of Health Professions in which: 1) an intensive literature search was conducted to uncover existing data on the environmental health work force; 2) thirteen authors were commissioned to prepare background papers on the various environmental health specialties for distribution prior to the workshop; and, 3) participants were selected who were experts in different specialties. After the workshop was held, an extensive effort was undertaken to synthesize, analyze and refine all workshop materials. This report contains the results of the workshop and the subsequent findings, synthesis, analysis and refinement.

The report begins with an overview and synthesis of the workshop and post-workshop environmental health work force analyses including a summary of estimates and a review of the main conclusions and recommendations developed in the course of the study. This is followed by the introductory remarks and keynote address delivered on the eve of the workshop. Next are summaries of the commissioned papers and the position papers prepared by workshop participants. The main body of the report ends with concluding remarks by the keynote speaker Mr. Larry Gordon. Appendices contain a bibliography, workshop agenda, list of participants and definitions of terms used at the workshop.

This report is unique, being the first attempt to analyze the environmental health work force in its entirety from the standpoint of supply, demand and need. It thus fills a void in an increasingly important area.

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1.1 THE FIELD OF ENVIRONMENTAL HEALTH

In 1979 the Surgeon General's Report on health promotion and disease prevention, *Healthy People*, gave special prominence to the role of environmental health in improving the health status of the American people. Three of the fifteen priority areas identified in the Report, Toxic Agent and Radiation Control, Occupational Safety and Health, and Accident Prevention and Injury Control, dealt specifically with environmental health. *Objectives for the Nation*, the 1980 report that initiated the implementation of the national strategy contained in *Healthy People*, clearly stated that the control of environmental hazards such as air and water emissions/effluents, hazardous wastes, and occupational exposure and injury is essential to health promotion and disease prevention. Of the 226 objectives for 1990 listed in the report, 57 or 25 percent are concerned with environmental health.

In 1986 the Public Health Service published *The 1990 Health Objectives for the Nation: A Midcourse Review*. As the title indicates, this report assesses progress toward reaching the objectives in the first half of the decade. The 20 objectives on toxic agent and radiation control, for example, were developed with little or no baseline data. For the most part, although it is clear that great progress has been made, national data are still not available to measure achievements in this area.

In the area of occupational safety and health, 20 objectives concerning the prevention of diseases, injuries and fatalities in the workplace were developed. As of 1985, four objectives related to improving health status had been met or were on track to be met by 1990. These four concern the incidence of work-related fatalities, disabling injuries, skin diseases and disorders, and work days lost due to injuries. Additional objectives concerned with developing standards for occupational safety and health and improving surveillance and evaluation systems are likely to be achieved by 1990. The Public Health Service could not measure progress toward achieving the majority of the remaining objectives in this priority area due to a lack of appropriate data.

Seventeen objectives on accident prevention and injury control were developed in 1980. Three of these were met by 1985. Nine more are expected to be met by 1990. Unlike the other two areas discussed, new data systems to measure progress in this area were being implemented for the remaining five objectives; however, a lack of data still makes measurement difficult.

The emphasis on environmental health in the 1990 *Health Objectives* and the expansion of the field of environmental health has had a significant impact on the environmental health work force. The demand and need for many types of practitioners has increased. Todays' practitioners must have an ever-increasing breadth and depth of knowledge.

The Environmental Health Work Force

Environmental health personnel work in a large variety of disciplines and address a multiplicity of problems in their attempt to prevent, eliminate and control environmental hazards. These include:

- Air, water and soil contamination
- Solid waste management
- Toxic waste management
- Radiation safety
- Workplace hazards
- Food contamination
- Noise control
- Vector control and pesticides
- Accidental injuries
- Consumer product safety
- Vehicular safety
- Housing
- Recreational areas and waters
- Land use
- Institutional health and safety

Employers

The majority of environmental health practitioners are employed by Federal, state and local public agencies. According to the 1979 Report on Allied Health Personnel, these agencies employed approximately 80 percent of the work force. In recent years, the percentage of the work force employed by private industry has been increasing. At the Federal level, in addition to the Environmental Protection Agency, employers include the Public Health Service components such as the Centers for Disease Control, the National Institute for Occupational Safety and Health, the Food and Drug Administration, and the National Institute of Environmental Health Sciences. Many state and local government agencies employ environmental health personnel, including public health departments, water and sanitation departments, environmental protection agencies, agriculture and fisheries departments, labor departments, and nuclear energy agencies. Private sector personnel work in industrial organizations, and for consulting firms, professional associations, and universities.

Classification

Environmental health encompasses many job classifications and titles, including sanitarian, engineer, industrial hygienist and environmentalist. The title "sanitarian" has been used for half a century to refer to that practitioner who applies technical knowledge based on the biological and chemical sciences to reach environmental health goals. The duties of the sanitarian have expanded substantially in recent years. In the 1940s, the emphasis was on inspection. More recently, that role has shifted to reflect the increasing complexity of environmental health problems resulting from man's technological advances.

Several attempts have been made to develop an all-inclusive classification scheme for the environmental health work force. The various sections of the American Public Health Association (APHA), including the Environment Section, have tried to develop such classifications for all public health personnel. A complete role delineation for sanitarians was developed by the National Environmental Health Association (NEHA) with financial support from the Bureau of Health Professions. That role delineation, dealing only with practitioners in the "sanitarian" category, was the first step in developing an improved credentialing process for the profession. The sanitarian role was divided into three positions, each of which could be classified according to major areas of practice, positional hierarchy (career mobility), levels of positions (entry vs. advanced), types of positions (generalist vs. specialist), and functions. The result of this study was the report "Blueprint of Knowledges, Skills and Attributes" which was used to develop the credentialing process, including proficiency examinations and self-assessment tools, for the entry-level positions of technician and technologist.

By the end of 1987, 31 states had mandatory and five states had voluntary registration programs for sanitarian practice. In order to qualify for the title of Registered Sanitarian or its equivalent (e.g., Environmentalist) in those states, a professional examination must be passed. Eligibility requirements in terms of education and experience vary somewhat by state. An increasing number of states are establishing a continuing education requirement for certification renewal. NEHA maintains the registration program it had developed in the role delineation project.

A major difficulty in assessing the environmental health work force is that it is composed of persons with very diverse educational backgrounds, skill levels, duties and job titles, who work in a variety of work settings and under varying auspices, both governmental and non-governmental. A clear definition of the components of the work force is needed before quantitative evaluation can be made. The work force can be described in two dimensions, a vertical one of job content and a horizontal one describing level of skill, knowledge and responsibility required for effective performance. The work force can be defined narrowly or broadly. As one paper prepared for this workshop noted, "Is a power plant operator whose primary responsibility is to generate power and secondarily to prevent air pollution a member of the environmental health work force?" Moreover, should only those job categories requiring an academic degree be included in the work force? The different ways in which this work force has been defined in the past accounts for the diversity of estimates.

An approach to defining the scope of the work force was provided by Larry Gordon in his opening address to the workshop (see page 36). In it, he distinguished "environmental health professionals" from "professionals in environmental health." The former category is educated in environmental health technology and in the basic public health skills of epidemiology and biostatistics. To a great extent they are educated in accredited schools of public health or accredited environmental programs outside schools of public health. They function in a variety of specialities as environmental epidemiologists and toxicologists, industrial hygienists, milk and food sanitarians, and institutional environmental health scientists and managers. Professionals in environmental health include geologists, engineers, biologists and physicians who work in environmental health programs but have not been educated in an environmental/public health context.

In addition to these two categories of professionals, two additional categories of environmental health personnel were identified: technicians and operators. These, are the largest categories in the environmental health work force, and are responsible for the day-to-day conduct of program activities and tasks. Their qualifications do not include an academic degree.

The categorization of the environmental health work force into four categories -- environmental health professionals, professionals in environmental health, technicians, operators -- provides a useful framework for estimating supply/demand/need. Also, it provides a distinction according to educational background and activities performed that rationally sorts out the many job titles in environmental health. Further, it provides a framework for directing programmatic efforts, such as education support, to alleviate personnel shortages.

Education/Training

Environmental health practitioners are trained in a multidisciplinary approach toward controlling, preserving and improving the environment. At one time, a four year degree in the biological sciences was not necessarily a prerequisite for entry into the field. Now, an increasing percentage of employers require four-year or graduate level degrees in an environmental health specialty. The second Report to Congress on Public Health Personnel in the United States estimated that half of the 26,000 sanitarians and industrial hygienists in the work force in 1978 had baccalaureate degrees, 30 percent had graduate degrees, and 15 percent had no degree.

The number of educational institutions offering environmental health programs is unclear. The 1979 Report on Public and Community Health Personnel stated that 67 schools offered environmental health courses at the undergraduate level and served approximately 600 students per year. About 15 to 20 of these schools had a comprehensive program equivalent to a major. By 1979 only six had been accredited by the National Council for Accreditation of Environmental Health Curriculum since it began accrediting such programs in 1967. Of the 150 graduate programs with courses in this field reported in 1979, only 60 awarded degrees in environmental health. About half of those degrees were awarded by 23 schools of public health. A 1980 study by the American Society of Allied Health Professions determined that there were 106 colleges and universities with environmental health programs. According to a 1986 study by Trenton Davis, there are 64 schools with undergraduate environmental health programs. Of these, 23 are accredited by the Accreditation Council. In addition, 24 schools of public health provide graduate level training in environmental health. Other programs in schools of engineering, medicine and health sciences offer graduate level training in such areas as environmental engineering, industrial hygiene, waste management, and occupational health.

The Bureau of Health Professions has exerted a major influence on environmental and occupational health training programs. Since 1957, it has supplied financial support at the graduate level. The Health Training Improvement Act of 1970 (P.L. 91-519) provided Allied Health Special Project Grants for associate and baccalaureate training in environmental health. During 1984, 189 students were awarded Public Health Traineeships in Environmental Health. There has been a fairly steady decline in the number of traineeships awarded in this specialty since 1979 when there were 300 trainees in the program. In addition to support from BHPr, the National Institute for Occupational Safety and Health provides educational support to the fields of occupational medicine, nursing and safety and to industrial hygiene. A total of nearly $9 million was provided in each of fiscal years 1984 and 1985 to support 15 Educational Resource Centers and other training programs at over 40 colleges and universities. A total of 143 graduate students and 1148 undergraduates were enrolled in these programs. The National Institute of Environmental Health Science provides support for research training in environmental health through National Research Service awards. Training programs are divided into four environmental areas: toxicology, pathology, mutagenesis and epidemiology and statistics.

Credentialing Issues*

Currently, credentialing is mostly voluntary, except in state and local agencies where a state registration or licensing law is in effect. Seldom do these laws affect nongovernmental

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* This material was prepared by Joe Beck, Western Carolina University

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employees. The primary reason for certification in the nongovernmental sector is to obtain insurance for liability and in the governmental sector is to enhance job security and pay.

The field of environmental health has long accepted people without a common knowledge base and attempted to train them in the agencies and bring them up to a minimum professional level of practice. Typically, the government first hired and provided baseline training and then industry hired the most promising or mobile of the government employees. The tremendous expansion and complexity of today's environmental problems are reflected in a large demand for professionals both in government and industry which is not even marginally met by the accredited programs in Environmental Health and Schools of Public Health. Faculty members of accredited environmental health programs typically support the view "that as awareness of the quality of our graduates grows so does the job market for them." Faculty often state that they can place far more students than they can attract into the programs. In one remote location, at the Western Carolina University nearly three requests are received for each graduate even though the program is only seven years old.

Recruitment into the academic programs is impeded by the lack of a singular professional identity with a recognizable educational background and the large number of ecology/biology programs. These programs, referred to as environmental science, have not been able to deliver on much more than a biology degree with the same employment opportunities for their graduates as that of a Biology major.

Currently, credentialing is mostly specialty certification such as Pesticide Application, Hazardous Waste, Air Pollution Industrial Hygiene, Asbestos Removal, Radiation Monitoring, Infection Control, Safety, or Sanitation. When a credentialing program is available, even on a voluntary basis, credibility is enhanced and in some cases, legal liability is reduced.

There are only three such credentialing bodies which certify generalists in environmental health. These are the National Environmental Health Association, American Academy of Sanitarians, and the Society of Environmental Health Scientists, The National Environmental Health Association requires a bachelors degree from an accredited Environmental Health program plus examination, or a course of study, requiring thirty hours of science, two years of environmental health experience and examination. The Academy of Sanitarians requires relevant masters education, evidence of exceptional service, contribution to the knowledge base of environmental health, and evidence of seven years of employment in the profession of which two must be supervisory. The Society for Environmental Health Scientists requires a bachelors degree in environmental health from an accredited program or seventy hours of a combination of mathematics, physical and biological science,

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contribution to the field, and varying years of experience dependent upon the level of degree held. While most view the Sanitarian as a specialist in the field of sanitary sciences, the term is used by the Academy and the National Environmental Health Association to denote a generalist. The name Sanitarian is widely used by local and state governments and within the Federal government's United States Public Health Service, but is seldom used by nongovernmental organizations.

Work force Estimates

No firm figures exist on the size of the environmental health work force. Estimates in the past of the total work force have ranged from 25,000 to 700,000, depending on the definitions used. The larger estimates of the environmental health work force come from a 1974 survey conducted by the Bureau of the Census and reported in a National Academy of Sciences Study (Volume V: Manpower for Environmental Pollution Control). That study reported approximately 700,000 persons directly employed in environmental protection.

A number of estimates of selected key components of that work force have been made. The 1974 survey identified about 135,000 professionals working in environmental protection or pollution control, but only about 25,000 of these dealt primarily with the human health implications of environmental hazards. In 1979, the National Environmental Health Association estimated that there were approximately 18,000 - 20,000 sanitarians in the work force. In the same year, the American Industrial Hygiene Association estimated that there were just over 5,000 industrial hygienists. The major changes in and immediately after this period were a trend away from the general practice typical of the 1960s to specialty practice and an increase in industrial employment of environmental health specialists.

The Second Report to Congress on Public Health Personnel (1982) estimated that there were 82,000 environmental health professionals in 1980, 15,000 of whom had graduate training in the field. These were reported to include:

- 20,000 sanitarians
- 6,000 industrial hygienists
- 4,000 teachers and researchers
- 26,000 occupational safety and health specialists
- 2,000 occupational health physicians and
- 24,000 occupational health nurses.

The Fifth Report to the President and Congress on the Status of Health Personnel (1986) made no overall estimate of the size of the environmental health work force. Instead, it summarized an Association of State and Territorial Health Officials study on full-time equivalent health agency staffs. This indicated that the agencies employed slightly more than 6,000 environmental health professionals of all types in 1982, including sanitarians, engineers, industrial hygienists, and researchers.

It is clear that there is much disagreement about the size of the environmental health work force. There are several reasons for this. An important one is the lack of generally accepted definitions of the scope of environmental health and the discrete specialties that compose its work force. Although NEHA's role delineation effort provides a definition for sanitarians, no similar definitions have been made for other specialties. Other factors that hinder accurate determination of the personnel supply are the diversity of job titles, the wide variety of responsibilities and programs in environmental health, differing employer agencies among the states, and the highly varied professional, technical and administrative skills and knowledge required in environmental health settings. The diversity of training programs and lack of an umbrella professional organization also make measurement difficult.

Impact of the Federal Government

The Federal government has always played an important role in coping with environmental health problems. This role has been expanded in the past twenty years. Federal legislation creating new environmental programs since 1970 has had a significant impact on the need for environmental health personnel. Following the enactment of the National Environmental Policy Act (1969), the Environmental Protection Agency (EPA) was created, and subsequently major environmental programs were enacted including:

- The Clean Air Act (as amended in 1970 1974 and 1977);
- The Federal Water Pollution Control Act (as amended in 1972 and as amended by the Clean Water Act of 1977);
- The Safe Drinking Water Act of 1974 (as amended in 1977);
- The Resource Conservation and Recovery Act of 1976;
- The Toxic Substances Control Act of 1976;
- The Federal Insecticide, Fungicide, and Rodenticide Act (as amended in 1972, 1975, and 1978); and
- The Noise Control Act of 1972 (as amended by the Quiet Communities Act of 1978);

The EPA was created to be the focal point for environmental problems. Environmental programs were transferred to it from other agencies. Since then several new environmental health agencies have emerged in the Public Health Service, including:

National Institute for Occupational Safety and Health
National Institute of Environmental Health Sciences
Center for Environmental Health, CDC
Agency for Toxic Substances and Disease Registry

The Federal government's impact on demand for environmental health personnel has not been matched by support for the supply. Only modest funding has been available for education and training. The private sector is playing an increasingly important role in work force supply/demand. Many companies are establishing environmental health positions. Private sector demand will continue to increase significantly. Thus, addressing work force issues adequately will require combined the efforts of government at all levels, private industry and professional associations.

1.2 PROJECT METHODOLOGY AND PROCESS

The Bureau of Health Professions (BHPr) of the Public Health Service is responsible for collecting, analyzing, and reporting information on the supply, demand, requirements, and distribution of all personnel in the health professions, including those in environmental health. In its biennial reports to the Congress on the status of health personnel, the BHPr is required to provide up-to-date information and analyses on training, supply, and demand in each health profession. The Bureau has been unable to obtain accurate estimates for environmental health for these reports. This results primarily from definitional problems in the field and a lack of accurate and curent data on the work force.

Although surveys of environmental health personnel and employers can obtain needed data, they are costly in time and money. Moreover, much work needs to be done before surveys can be initiated. The scope of environmental health and the functions, activities and capabilities of the providers of services need to be defined. Rapid expansion in many areas has made it difficult to define the boundaries of environmental health and to delineate the functions and responsibilities of the work force.

In an effort to rectify this situation and develop estimates of the size of the environmental health work force, the Bureau of Health Professions contracted with Levine Associates, Inc. to commission a series of papers by and conduct a workshop of experts in the field. The experts were asked to synthesize the current knowledge on the supply and required competencies of and the demand and needs for environmental health personnel. In addition, Levine Associates was directed to assist in developing

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strategies for the acquisition and analysis of environmental health work force data and to provide Federal, state and local governments, academic institutions and professional organizations with information for program and training activity development.

The Bureau has used workshops effectively several times in recent years to discuss and resolve important issues pertaining to environmental health personnel. There was a workshop on preparation for practice in this field in July 1981. Among the highest priority issues there were the availability of qualified faculty, training needs of currently employed personnel, and defining the competencies to be achieved by graduate training in environmental health. Another meeting of environmental health specialists was held in November 1984 on needs for training, particularly in risk assessment. Development of a model approach to risk assessment and hazard elimination was recommended.

As a first step toward meeting the project's objectives and preparing for the workshop, Levine Associates worked with its consultants, Mr. Larry Gordon, Director of the New Mexico Department of Health and Environment, and Dr. Lawrence Krone, Chief of the Delaware Bureau of Environmental Health, to develop a working definition of the field of environmental health. A literature search of existing definitions of the field was also conducted. The following definition was selected:

> **Environmental Health** is the systematic development, promotion and conduct of measures that modify or otherwise control those external factors in the indoor and outdoor environment which might cause illness, disability or discomfort through interaction with the human system. This includes not only health and safety factors, but also aesthetically desirable conditions in accordance with community demands and expectations.

This definition covers the diverse specialties within the field of environmental health. As the project was limited to ten commissioned papers on the various specialties, the next step was to combine and merge the different specialty areas into ten groups in such a way that all environmental health practitioners were included. The following groupings were determined:

I. Air: Indoor and Outdoor Air Quality and Noise Control.

II. Water: Water Quality (wastewater control) and Water Supply.

III. Milk and Food: Protection of the Milk and Food Supply.

IV. Land Use Planning and Management: Land Use Planning, Resource Management, Transportation, Population growth and other related activities.

V. Occupational Safety and Health: Industrial Hygienists, Occupational Safety personnel, Occupational Health Physicians, and Occupational Health Nurses.

VI. Hazardous Materials: Hazardous Waste Management, Toxic Substance Control, and Other Related Activities.

VII. Institutions: Institutional Safety & Health and Radiological Health.

VIII. Other Areas: Practitioners not covered by the first seven topics, including those working in Housing, Solid Waste Management, Vector Control, Injury Control (Non-workplace), and Consumer Protection and Safety.

IX. Risk Assessment, Epidemiology and Toxicology: Risk Assessors, Environmental Epidemiologists, and Environmental Toxicologists.

X. Academicians: Faculty in Environmental Health and Science Programs (at the undergraduate and graduate levels in and outside of schools of public health).

It was determined that the commissioned papers should focus primarily on professionals as this was the group in which the Bureau of Health Professions is most interested. A professional was defined as "a person filling a position for which at least a Baccalaureate degree is usually required and conducting tasks that meet the definition of environmental health."

Many individuals in environmental health were contacted to identify potential paper authors for the above-listed topics and possible workshop participants. The staff telephoned the many professional organizations which represent the field, including:

- National Environmental Health Association
- American Public Health Association
- American Industrial Hygiene Association
- Association of State and Territorial Health Officials
- American Academy of Environmental Engineers
- Association of Schools of Public Health
- American Association of Occupational Health Nurses
- International Association of Milk/Food and Environmental Sanitarians
- Water Pollution Control Federation
- American Waterworks Association
- Air Pollution Control Association
- National Environmental Training Association
- National Solid Waste Management Association
- National Restaurant Association
- Public Health Foundation

The following Federal government agencies were contacted:

- Environmental Protection Agency
- US Navy
- Food and Drug Administration, PHS
- Health Resources and Services Administration, PHS
- National Institute of Environmental Health Sciences, NIH
- National Institute for Occupational Safety and Health, CDC
- Center for Environmental Health, CDC
- Agency for Toxic Substance and Disease Registry, PHS

In addition, numerous state and local government agencies, academic institutions and industries were telephoned. As a result of these contacts, a long list of environmental health professionals with interests in manpower was developed. At the same time, a literature search of published, unpublished and on-going research on the environmental health work force was conducted. Pertinent articles were summarized according to the ten topic areas. A complete bibliography is included in the Appendix E.

Using the list of potential authors and participants and with the aid of the consultants and the Project Officer, Mr. Barry Stern, authors for six of the topic areas were selected. The National Environmental Health Association was contracted to select the remaining four authors and oversee their papers.

An outline and set of definitions for use by the authors were developed. Definitions for credentialing, supply, demand, need, and other related terms were determined to ensure that they were used consistently by the authors. In addition, each author was given the portion(s) of the literature search summary which pertained to his/her topic area. The outline which guided the authors included the following:

- Description of the area and work force;
- Requirements for practice, including education, credentialing and professional development;
- Education;
- Supply, demand, need, and requirements of current workforce;
- Historic trends in supply and demand;
- Future supply and demand;
- Implications of current, past, and future supply/demand for education;
- Implications of current, past, and future supply/demand for employers;
- Data gaps; and,
- Conclusions and recommendations.

Workshop participants and alternatives were chosen from the large listing developed earlier. Participants were selected on the basis of their work force sector (academic, state/local government, private/industry, association or Federal government), previous work or interest in manpower studies, specialty field, and geographic location. In selecting the approximately 50 participants, Levine Associates and the project officer tried to ensure that each work force sector was equally represented and that representatives of the primary professional organizations were present. The final participant list is given in Appendix B.

Plans were made to hold the workshop at Airlie House, a workshop center in Warrenton, Virginia on July 13 - 16, 1987. All arrangements were made by Levine Associates. An agenda, which provided for the presentation of introductory and commissioned papers and for conducting three workshop sessions and two plenary sessions was developed. A copy is contained in Appendix A.

Originally, four workgroups were created, each considering one of the following topics for all environmental health specialties: (1) factors impacting on supply/demand/requirements now and in the future; (2) current and future status of environmental health work force supply/demand/requirements; (3) meeting the demand/requirements for environmental health personnel; and (4) quantitative and qualitative shortages that need to be overcome in assuring an adequate work force. It was later decided that the workgroups could better focus on the key issues of supply, demand and need if each waas assigned specific specialty areas. The five workgroups which were finally set up to address work force characteristics were as follows:

- Air and Water
- Milk and Food and Institutional Safety & Health
- Hazardous Materials Management, Risk Assessment, Epidemiology and Toxicology
- Occupational Safety & Health and Radiological Health
- Land Use Planning & Management, Solid Waste Management, Housing, Vector Control, Injury Control, and Consumer Protection & Safety

Each participant was assigned to the group that most closely matched his/her training and current position. Care was also taken to ensure that each group had representatives from the Federal government, state/local agencies, industry, professional organizations, and academia. Geographic representation was also considered in group assignments.

Group leaders were selected from among the participants by the Project Officer and Levine Associates staff for their experience in leading group discussions and developing consensus judgments on the issues addressed. A reporter was also chosen to make group reports during plenary sessions. Members of Levine Associates' staff served as recorders for each group. A tape recorder was used for continuous coverage of all sessions.

Although the groups were not required to pursue a specific agenda, they were charged with addressing the following issues:

- Definition of the environmental health work force with particular reference to the specialties considered by the workgroup.

- Current and future status of the supply, demand and needs in the various specialty areas.

- Factors impacting on supply, demand and needs, currently and in the future.

- Meeting the demand and needs for environmental health personnel.

- Setting priorities for an adequate work force.

- A plan for collection of data on the environmental health work force.

A copy of the detailed "Charge to the Workgroups", which was distributed to all participants prior to the workshop, is provided in Appendix C. The major goal was to arrive at quantitative estimates of the supply, demand, and need in each specialty area using material in the commissioned papers, data from the literature search, and information and judgment provided by workshop participants. The table shown on the next page was completed for each major specialty area. The tables for each specialty area were combined to produce estimates of the current supply of and demand and need for the total environmental health work force and by 1992. These estimates are discussed in the next section.

1.3 ESTIMATES OF SUPPLY/DEMAND/NEEDS

The method employed at the workshop was to divide the participants into five groups each responsible for estimating supply, demand and need in two environmental health specialty categories. Each workgroup conducted intensive deliberations which resulted in position papers supporting the estimates. This task was difficult because, as identified in the group discussions and in the background papers, there are numerous limitations and constraints on making accurate estimates of work force supply/demand/needs in environmental health. The most important of these are:

- Defining Supply/Demand/Need

In analyzing the work force in health there are generally accepted definitions of work force supply, demand and need. The concept of supply usually connotes "qualified" supply - members of the work force who have attained certain credentials such as a

TABLE SHELL FOR ESTIMATES OF WORK FORCE SUPPLY, DEMAND AND NEED

SPECIALTY AREA: ____________________________

YEAR	SUPPLY	DEMAND	NEED
1985			
1987			
1992			

DEFINITIONS

Supply: The number of qualified personnel available to practice in a given occupation, including the employed (or self-employed) and those seeking employment in the field.

Demand: The number of funded positions in a given occupation, whether filled or unfilled.

Need: The number of persons in an occupation judged by experts as required for a desirable level of service.

college degree, a certificate, or a license. This definition was difficult to apply across the specialties and caused confusion in some workgroups and some lack of comparability of data across specialties. In synthesizing the data, only "qualified" persons were counted in the "EH (Environmental Health) Professional" column of Exhibit 1.1. The number of professionals in need of more training was estimated and shown in the "Other Professional" column of Exhibit 1.1 as well as in Exhibits 1.2 and 1.3. Also, the concept of "demand" was difficult for the workgroups to apply since demand is defined as "funded" or "budgeted" positions in the specialty. For most specialties in environmental health no such data exist. Thus the data synthesis has deleted demand data. On the other hand, the concept of "need" presented little difficulty and the data are considered to be reasonably accurate.

- Defining the Boundaries of Environmental Health

All activities related to controlling environmentally influenced disease can be said to impact on health but some are more directly related to health than others. Even those with very indirect effects on health may influence the quality of life and, thus, can be considered to be within the domain of health. The limits of environmental health must be clearly defined in order to derive generally acceptable and consistent measures of the work force.

- Diversity of Environmental Health

The diversity in environmental health exists along many dimensions -- subject matter, technologies employed, settings, employers, provider roles, and clients. There is also geographic diversity. Some environmental health problems are more prevalent in certain areas of the nation than in others. This diversity is reflected in the large number of interest groups and professional associations in environmental health.

- Rapid Change

Recognition of the chemical and physical determinants of environmentally induced health problems is increasing. As programs are established to address the problems, the environmental health field is experiencing significant changes in program content, emphases, size and new job titles are created as the demand for personnel expands. Keeping accurate count of personnel supply and demand in such a dynamic situation is a difficult task.

- Role Articulation

There are no widely accepted career ladders in environmental health. Career ladders articulate the educational requirements for the various levels of knowledge and expertise required. Credentialing criteria, such as academic degrees, certification, registration and licensure, could be more easily formulated if acceptable career ladders existed. Credentialing makes the determination of valid estimates of work force supply/demand/needs more accurate.

- Overlapping

There is considerable overlapping of areas of responsibility within the field of environmental health -- in problems, in measures that are taken to solve problems, and in activities and responsibilities of personnel who carry out these measures, thus decreasing the accuracy of estimates of supply and demand.

- Evaluative Criteria

Criteria are lacking with which to evaluate outcomes of environmental health interventions. This makes it difficult to determine work force needs scientifically. Thus, expert judgment becomes the sole basis for assessing needs. But this approach does not differ from work force assessments that are made in other health fields where the long-term outcomes of interventions are also not readily measurable.

- Data Bases

A major concern of the workshop was the absence of timely, accurate and relevant data for evaluating the environmental health work force. Existing data are fragmented, limited to selected occupations and outdated. Considering the growing importance of environmental health, the participants believed that the establishment of a comprehensive, accurate and current data base on work force supply/demand/needs is a high priority goal.

Despite these severe constraints, the participants were able to use available knowledge and expert judgment to reach consensus on a comprehensive set of estimates. While not a substitute for primary data collected in surveys, these estimates do provide useful information for the development of plans and policies to achieve an adequate environmental health work force.

The Estimates

Exhibit 1.1 summarizes the quantitative findings regarding work force supply from each workgroup's position papers. The data show that there are an estimated 715,000 personnel in the environmental health work force. Two-thirds of these are technicians and operators. About one in ten are environmental health professionals. The largest specialty area is water - watersupply and wastewater -- accounting for over 50 percent of the entire work force. The next largest area is air quality with 100,000 workers. However, less than five percent of the air and water categories work force consists of environmental health professionals. The third largest category is occupational safety and health with 96,000 personnel, nearly half of whom are environmental health professionals.

Participants at the workshop felt that supply and demand were essentially in balance for most specialties. They did, however, estimate that there are now at least 15,000 vacancies.

Exhibit 1.2 takes a closer look at the 235,000 professionals in the field of environmental health in 1987. Nearly 40,000, or 17 percent of all professionals in the field, need additional training. While half of these are occupational health nurses, 9 of the other 17 categories also have significant numbers who need additional training. In addition, 121,000 more professionals are needed in environmental health. About half of the additional persons are needed in the specialty of hazardous waste.

Exhibit 1.3 provides projections to the year 1992. Although there are some differences, the problems identified for 1987 are projected to continue through 1992. Although the number of additional professionals needed by 1992 is projected to decline, from 121,200 to 74,400, the number needing additional training is expected to rise slightly.

1.4 RECOMMENDATIONS

Among the many recommendations made by the workshop participants for meeting both quantitative and qualitative needs were:

- Increase Federal support of basic (e.g., collegiate) education programs.
- Provide funds to upgrade the professional skills and knowledge of individuals in technical positions.
- Develop role delineation models for the major environmental health specialties.
- Develop a basic or core curricula for the various specialties in environmental health.
- Place more emphasis on graduate training including the preparation of academicians.
- Establish credentialing (accreditation of educational programs and certification of people) policies and procedures.
- Develop effective continuing education system.
- Explore the cross-training of other health professionals in the fundamentals of environmental health.
- Develop innovative solutions to work force problems such as a Food Protection Academy modeled after the FBI Academy.

A major conclusion of the experts was that there is a great need for the U.S. Public Health Service to play a more active and meaningful role in expanding and improving the environmental health work force. Leadership should be provided in developing effective environmental program management. Together with the Environmental Protection Agency and other governmental agencies and professional associations, a national plan should be developed by the Public Health Service for meeting work force needs. That plan should include study of appropriate labor markets in terms of responsiveness to emerging environmental legislation and programs, and delineation of policies to stimulate the development of needed occupations and skills.

Finally, there was unanimous agreement that severe data gaps exist that must be closed. Considering the size of the work force and its vital importance to the health of the American people, the need for accurate and reliable data on supply/demand/needs is clear. The Federal government has an appropriate role in funding a comprehensive survey of the environmental health work force as defined by the experts. One possible source of funding is a percentage (one percent suggested) set-aside from one or more of the environmental health laws (e.g., Superfund).

EXHIBIT 1.1 ENVIRONMENTAL HEALTH WORK FORCE SUPPLY (FTEs), 1987

GROUP	SPECIALTY	TOTAL	PROFESSIONALS		TECHNICIANS	OPERATORS
			EH	OTHER		
	TOTAL	715,000	80,000	155,000	239,000	241,000
I	Air Quality Workers[1]	100,000	4,000	14,000	10,000	72,000[2]
	Water Supply Personnel[3]	186,000	8,000	34,000	60,000	84,000
	Wastewater Personnel[4]	219,000	8,000	36,000	90,000	85,000
II	Milk and Food Sanitarians	14,000	8,000[11]	2,000[11]	4,000	----
	Insitutional Environmental Health Manager/Scientist	18,000	4,000[11]	14,000[11]	----	----
III	Environmental Epidemiologists	500	500	----	----	----
	Environmental Toxicologists	3,000	3,000	----	----	----
	Hazardous Materials Manager[5]	20,000	300	9,700	10,000[11]	----
IV	Industrial Hygienist	14,000	11,000	----	3,000[11]	----
	Occupational Health Nurses[6]	29,000	11,000	18,000	----	----
	Occupational Physicians[7]	3,000	1,000	2,000	----	----
	Occupational Safety Personnel[8]	31,000	13,000	13,000	5,000	----
	Radiological Health Personnel[9]	10,000	1,000	7,000	2,000	----
V	Land Use Planners	4,000	2,000[10]	2,000	----	----
	Solid Waste Managers and Support Personnel	11,000	1,000[10]	1,000	9,000	----
	Housing Workers	14,000	1,000[10]	1,000	12,000	----
	Vector Control Workers	32,000	1,000[10]	1,000	30,000	----
	Injury Control Workers	4,400	100	300	4,000	----
VI	Academicians	2,100	2,100	----	----	----

Note: Footnotes for this table may be found on pages 24 and 25.

Definitions of specialties and other key terms are in Appendix D.

EXHIBIT 1.2 SUPPLY AND NEEDS: PROFESSIONAL WORK FORCE IN ENVIRONMENTAL HEALTH, BY SPECIALTY, 1987

	SUPPLY		
SPECIALTY	TOTAL	NEED ADDITIONAL TRAINING*	ADDITIONAL PERSONS NEEDED
TOTAL	235,000	37,500	121,200
Air	18,000	----	----
Water Supply	42,000	----	6,500
Wastewater	44,000	----	10,000
Milk/Food San.	10,000	500	7,000
Inst. Env.	18,000	5,000	10,000
Env. Epi.	500	----	100
Env. Tox.	3,000	----	400
Haz. Materials	10,000	5,000	65,000
Industrial Hyg.	11,000	----	2,500
Occ. Nursing	29,000	18,000	----
Occ. Phys.	3,000	2,000	----
Occ. Safety	26,000	5,000	----
Rad. Health	8,000	500	----
Land Use	4,000	----	2,000
Solid Waste	2,000	500	3,500
Housing	2,000	500	5,000
Vector	2,000	500	4,000
Injury	400	----	5,000
Academicians	2,100	----	200

* Estimated by BHPr and Levine Associates after the workshop was concluded, based on notes taken during conference discussions.

EXHIBIT 1.3 SUPPLY AND NEEDS: PROFESSIONAL WORK FORCE IN ENVIRONMENTAL HEALTH, BY SPECIALTY, 1992

SPECIALTY	SUPPLY		ADDITIONAL PERSONS NEEDED
	TOTAL	NEED ADDITIONAL TRAINING*	
TOTAL	297,450	39,500	74,400
Air	19,000	----	----
Water Supply	44,000	----	6,800
Wastewater	47,000	----	10,000
Milk/Food	11,000	500	6,500
Inst. Env.	12,000	3,000	10,000
Env. Epi.	750	----	200
Env. Tox.	3,500	----	2,000
Haz. Materials	50,000	5,000	25,000
Industrial Hyg.	14,000	----	4,000
Occ. Nursing	33,000	20,000	----
Occ. Phys.	5,000	3,000	----
Occ. Safety	26,000	5,000	----
Rad. Health	14,000	----	----
Land Use	3,500	----	2,000
Solid Waste	4,000	1,000	----
Housing	4,000	1,000	----
Vector	4,000	1,000	3,000
Injury	500	----	4,500
Academicians	2,200	----	400

* Estimated by BHPr and Levine Associates after the workshop was concluded, based on notes taken during conference discussions.

NOTES TO EXHIBIT 1.1

(Note: The abbreviations EHP and PEH refer to Environmental Health Professionals and Professionals in Environmental Health).

(1) Numbers derived from Group 1 Position Paper as follows:

```
Total work force in Air: 27,925
           Technicians: -10,150
                        --------
    All Professionals:  17,775 = 18,000
Env. Health Professionals:     Epidemiologists      75
                               Toxicologists       100 (1/2 of 200)
                               Env. Engineers    2,000
    17,775 (PEH,EHP)           Physicians           50
  -  2,275                     Sanitarians          50
    ------                                     -------
    15,500                                       2,275
  X    10% (Est. % EH prof. in group)          + 1,550
    ------                                     -------
     1,550 (includes portion of chemists)        3,825 = 4,000 (EHP)
Other Professionals:     18,000
                        - 4,000
                        --------
                         14,000 (PEH)
```

(2) Number of operators derived from estimates of 1981 EPA Workshop (p. 143).

(3) Numbers derived from Group 1 Position Paper as follows:

```
Total Work force in Water: 186,000
             Technicians: - 60,000
               Operators: - 84,000
                          --------
      All Professionals:   42,000
Env. Health Professionals:     Epidemiologists     100
                               Toxicologists       200 (1/2 of 400)
    42,000                     Env. Engineers    1,000
  -  4,300                     Sanitarians       3,000
    ------                                     -------
    37,700                                       4,300
  X    10%  (includes portion of chemists)       3,770
    ------                                     -------
     3,770                                       8,070 = 8,000 (EHP)
Other Professionals:     42,000
                        - 8,000
                        --------
                         34,000 (PEH)
```

(4) Technicians Include 85,000 Operators. Numbers derived from Group 1 Position Paper as follows:

Total Work force in Wastewater: 219,800
Technicians: - 90,000
Operators: - 85,000

All Professionals: 44,800

Env. Health Professionals:

Epidemiologists	100
Toxicologists	200
Env. Engineers	2,000
Sanitarians	2,000
	4,300
	4,050
	8,350 = **8,000** (EHP)

44,800
- 4,300

40,500
X 10%

4,050

Other Professionals: 44,800
- 8,350

36,450 = **36,000** (PEH)

(5) Group III's paper states that the 1987 supply is 50,000. This refers to people, not FTE's. Assuming that about 20 percent of their time is spent in hazardous materials management gives a supply of 10,000. The majority are not EH Professionals; the estimated split is 300/9,700 (EHP/PEH).

(6) Group IV's paper estimates a 1987 supply of 11,000. This reflects only COHN's and COHN eligibles. Estimated demand (29,000) includes all positions, regardless of credentials. The uncertified are considered "Other" professionals.

(7) Group IV's paper provides estimates 1,200 as the 1987 fully qualified supply. The demand estimate (3,000) includes all positions regardless of qualifications. Uncredentialed practitioners are counted under "Other" professionals.

(8) 26,000 supply of professionals based on a 1977 NIOSH report; arbitrarily split 50/50 into EH Professionals and "Other". This is less than the position paper value because we exclude OH physicians and nurses included in other categories.

(9) Assume 15 percent EH Professionals, 85 percent other professionals, and an estimated 2,000 rad. protection technicians

(10) Professional totals from Group V Position Paper arbitrarily split 50/50 into EH Professionals and "Other".

(11) These estimates by BHPr and Levine Assoc. were made after the workshop was concluded based on notes taken during the conference and do not appear in workgroup position papers.

2. WELCOME AND OPENING REMARKS FROM THE PUBLIC HEALTH SERVICE

Faye G. Abdellah
Deputy Surgeon General and
Chief Nurse Officer

Good evening ladies and gentlemen. It is both an honor and a privilege to be with you. It is especially refreshing to be with environmental health specialists.

I bring you greetings from our Surgeon General, Dr. C. Everett Koop and congratulations to Levine Associates and the Bureau of Health Professions who planned this important workshop. The initiative that you are taking to focus on supply, demand and needs in the environmental health work force provides important leadership to our overall national aspirations in prevention. This evening I would like to share with you briefly the process by which the Public Health Service arrived at the national health objectives of 1990 and then specifically address how you as health professionals and environmental health specialists can help to achieve these objectives. The process of objective setting bears no relationship to the regulatory process. It is clearly an effort to assess local and regional priorities, and capture local and regional opportunities. The objectives represent a consensus rendering of what various experts around the country feel ought to be achieved if we as a nation devote our attention to certain outcomes. It is an effort to apply the management by objectives process to the health field on a national scale.

The motivating context for the objectives effort is influenced by the interplay of various biological, behavioral, environmental and social risk factors. It is this interplay that is so important. These factors can in turn be influenced by the delivery of a variety of treatment services, health promotion services, health protection services, and other social services. The ability of a society to deliver those services is dependent upon the availability of appropriate intervention technology, the fiscal resources necessary to pay for the services, and a societal willingness to commit the resources to deliver the services. Research efforts are also important in developing effective intervention technologies. At the heart of the scheme is the need for appropriate surveillance systems which can gather information about health status and risk factor prevalence and feed that information back to affect the nature of service programs, societal attitudes and norms, and research and development activities. The lack of data is the weak link and I'm hoping that this workshop will help to strengthen that link.

At the Federal level, we have been involved in a process over the last several years which focused on assessing how the various elements involved can be influenced to improve health status. In 1970, the report Healthy People: The Surgeon General's Report on Health Promotion and Disease Prevention, was issued. In recent years, considerable attention has been placed on protecting people from environmental hazards. Of the 226 health objectives issued in the report, 57 (25 percent) are in the areas that will be considered at this workshop, specifically:

- Toxic agent and radiation control
- Occupational safety and health
- Accident prevention and injury control

The recently issued Midcourse Review of the 1990 health objectives shows some progress in achieving the objectives in environmental health. Of the 20 objectives in toxic agent and radiation control, none have been achieved as yet, four are on track, and there are no data to track progress for 16 objectives.

There has been some effort to apply the management by objectives (MBO) process to the health arena. The major categories that serve as the focus of any management by objectives exercise include: outcomes, strategies, productivity, marketing, and innovation. The following table compares these catgories for business and health enterprises:

Category of Objective	Business	Health
Outcome	Profits	Reducing morbidity and mortality
Strategy	Product type and mix	Risk factors that are targeted
Productivity	Labor and Capital Mix	Scope of service provided
Marketing	Attitudes and awareness of clients	Attitudes and awareness of public and professionals
Innovation	Product Improvement	Surveillance evaluation and research efforts to enhance the effort

Factors influencing health status are very susceptible to the management by objectives effort. Specifically, they include: activities undertaken within service programs, the societal attitudes and norms, the research and development exercises, and the surveillance activities.

This brings me to the current stage in the process. Now that the objectives for the national level have been agreed upon through this relatively elaborate process, we have moved into the implementation phase. And this includes the Federal efforts. Though the objectives which were established were not Federal but national, there is clearly a substantial amount that the Federal government can do to facilitate their achievement.

The job of the Public Health Service has been to take responsibility to involve sister agencies inside and outside the Department of Health and Human Services in the identification of those objectives which are important to Federal priorities, and to develop implementation plans for the Federal contribution to the objectives.

In addition, an information tracking system is being established to facilitate the monitoring of progress. This system will be automated, collecting relevant data from various sources around the country, including the data systems of the National Center for Health Statistics and the Centers for Disease Control as well as individual surveys commissioned through such groups as the Association of State and Territorial Health Officials, and through opinion polls like those conducted by the Gallup and Harris companies. The system will focus on distilling the best data that we have available on the objectives, and keep a running account of those data. As one might suspect, the data issue is one of the most important components of this whole effort. One of the major obstacles is the fact that we don't have data available for many objectives.

The Midcourse Review makes amply clear that achieving the objectives for health protection requires large numbers of highly trained environmental health professionals. It is extremely important to know how many of these health professionals currently exist, how adequate this supply is in relation to demand, and what are the future demands and needs.

Like the data gaps in tracking progress in meeting the health objectives, there are many data gaps in assessing the environmental health work force. This is another concern of this workshop. It is clear then that you will address very timely and important issues in achieving the goals and objectives of the Surgeon General's initiative in protecting and improving the health of the American people. I wish you much success over the next three days in achieving your goals.

William Robinson
Chief Medical Officer
Health Resources and Services Administration

Almost daily we read that chemical and physical agents potentially hostile to human health are the most perplexing problems faced by the environmental and occupational health work force. The leading causes of death and disabilities are known, or strongly suspected, to have chemical or physical agents as major etiological factors. Problems inherent in the safe use and disposal of possibly harmful substances are complex, and involve technical, political and social issues. It is estimated that there are more than 620,000 solid waste sites located throughout the nation, many containing hazardous waste that pose significant risks to human health and the environment. Production of synthetic chemicals has increased significantly and yet implementation of prevention and control measures lag far behind research and knowledge.

Environmental health is complex and diverse, representing a variety of occupations, functions and skill requirements. Occupational titles include, but are not limited to, sanitarians, environmental health specialists, industrial hygienists, engineers, scientists, chemists, hydrologists, occupational physicians, occupational nurses and many others. To further illustrate the complexity, diversity and interest in this subject, the Public Health Service has seven major organizations working on environmental and occupational health issues.

During the last ten years, the Bureau of Health Professions in the Health Resources and Services Administration has supported at least fourteen projects in environmental health totaling almost $2.0 million. These projects have covered such areas as professional role delineations, development of self-assessment instruments, examination development, development of self-paced learning modules, continuing competency, a study of curriculum relevance, and the assessment of risk and the management of hazardous materials. The Public Health Service has been concerned about environmental health for many years even without a legislative mandate from Congress.

In various regions, states and local governments, there exist similar public organizations concerned with environmental health matters such as state health departments, state environmental protection agencies, licensure boards, sanitation commissions and other bodies.

In the non-governmental sector, there are numerous bodies devoted to environmental issues -- institutions of higher education, professional credentialing bodies, private industry and numerous professional and technical associations.

The multitude of organizations and individuals is both a "strength" and "weakness." It is a double-edged sword. It is a weakness because each organization has its own philosophy, program and political agenda, or represents a particular professional interest. Higher educational institutions are concerned with academic preparation and research. Governmental agencies administer laws and regulations that often vary across political jurisdictions. Private industry develops products or services for profit, and professional associations are devoted to representing their membership and furtherance of the profession. All of these motives are driven for positive purposes, but sometimes, these interests do conflict.

On the other hand, this diversity may be your greatest asset and strength. Hundreds of organizations and thousands of people work in the field of environmental health. Rapid change can occur if you can harness that strength and channel it to speak with one unified voice. That voice must speak to identify specific problems and take action steps to resolve current issues; identify needed legislative changes at the Federal, state and local levels; and develop a short- and long-range strategy that is acceptable, clear and defensible among all groups concerned with environmental health. Tough fiscal and policy decisions must be made throughout our society to reduce environmental health hazards.

If you review the 1979 First Report to Congress on Public and Community Health Personnel and subsequent reports, you will find that solid data are not available to present a clear picture of many of the issues that need to be addressed. In this workshop, we will focus on the work force requirements, knowledge and skills needed to perform various tasks and a clear definition of the functions performed by various environmental health personnel. There are very limited data available to answer some of the most basic questions. For example:

- How many personnel are there in the various environmental health occupations?
- What are the rates of entry into these professions?
- What are the rates of attrition from these professions?
- Exactly what functions do environmental health personnel perform?
- Where do environmental health personnel work?

- What are the professional development needs of the work force, both in basic academic preparation and in continuing professional education?

- And many other questions that need answers.

In previous forums, workshops and conferences, it has been clear that the environmental work force is difficult to characterize. Reasons cited include the existence of diverse job titles, many specialities and the interdisciplinary requirements of many environmental health positions. Also, one organization does not exist as an "umbrella" entity to represent and oversee broad areas of environmental health. No one has successfully been able to bring this myriad of environmental representation together for purposes of sharing and analyzing this difficult-to-collect data.

The goal of this workshop is to bring together experts representing national professional organizations, academia, governmental organizations and private industry to identify studies that will form a basis for analyzing current and future demand and requirements of the environmental health work force and to foster cooperative relationships for data collection that will characterize the work force accurately. We also hope that this workshop will sharpen the focus upon these issues and motivate state and local governments, educational institutions and professional associations to effectively pursue private funding to help solve educational and practice issues. As you probably know, this is the era of "private sector initiative."

I have obtained a copy of each of your papers to be presented. I will take them back to a meeting of the policy staff and discuss them with Dr. Sundwall and the people who report to him in order to be ready to receive the outcome in terms of your recommendations at the end of the workshop.

I hope that this workshop provides the proper setting and environment to accomplish all of these purposes. That is my challenge to you for the next three days.

Thomas Hatch
Director, Bureau of Health Professions

You have heard tonight from all levels of the Public Health Service. It is my pleasure to welcome you on behalf of the sponsoring agency of the workshop, the Bureau of Health Professions of the Health Resources and Services Administration, Public Health Service.

The Bureau takes great pride in the extensive work that we do in the collection and analysis of workforce data to track the health field. Because of the size of the health industry, this is a monumental task. At last count there were approximately six to seven million people working in about 150 different health professions or occupations. The Bureau is currently engaged in extensive work at the national level with respect to the extent of shortages or surpluses of personnel in the health field. The most publicized of these is the apparent oversupply of physicians. We have a considerable number of activities dealing with the issue, including Congressionally-mandated reports and advisory councils working to develop projections on the future supply of physicians. On the other side of the coin is the rather severe shortage of nurses in this country. The Department is very concerned about the shortage and what will might happen in the future to the supply of nurses.

The Bureau, which celebrated its 20th anniversary last month, has been involved in and concerned about environmental health issues since support for the training of personnel in public health through traineeships to students in environmental health and other public health disciplines was enacted. We've been involved in that now for almost 30 years -- I believe the first traineeships were awarded in 1956. Our support for traineeships for environmental health students and other public health personnel peaked in 1979 when we were supporting as many as 300 environmental health students both inside and outside of Schools of Public Health. At the same time, we provided, and continue to provide, basic operating support for Schools of Public Health. In addition to that, in the 1970's and early 1980's, we provided curriculum development grants totaling about 1/2 million each year. As Bill Robinson mentioned, over the past several years nearly $2 million has been invested in the development of role delineations, examination development and self-assessment instruments for environmental health specialists.

I would suggest that the central issue for this workshop be: to what extent are continuing problems in the environment due to problems with the workforce? Problems in the workforce might relate to the total numbers, distribution, utilization, or preparation of those currently employed. In order to answer this question, we must define and count the workforce, and evaluate in some fashion its adequacy in terms of numbers, distribution and utilization.

The Bureau has attempted to do this in its biennial reports to the Congress on the status of health personnel. Environmental health, along with other disciplines, has plagued us with definitional problems and a lack of data. The environmental health sections have been among the poorest in the reports because of these problems.

The 1982 Report to Congress provided an in-depth look at Environmental Health and Occupational Health. A copy of that report is in your packet. As you study it, please note page 145 which contains estimates of the workforce ranging from 25,000 to 600,000! The 1984 and 1986 reports have relatively little information on environmental health.

I'd like to share with you a few of the problems that we have had in preparing the 1988 draft report. I hope this workshop will begin to help us solve some of these problems. We have found no way to accurately separate those persons who work in environmental health from those in environmental protection and environmental management. The large -- 600,000 or more -- estimates come from surveys of engineers conducted by the Census Bureau. The majority of these personnel are engaged in "environmental protection" with only a small percentage specifically in health. Our best estimate of the supply of environmental health professional personnel is 109,000 as shown on the Exhibit 2.1.

The adequacy of this workforce is an even harder question. The demand, requirements, and need information is based on professional judgment, anecdotal comments obtained at workshops and conferences, and a few surveys. They point to a serious deficiency in the workforce that deals with hazardous waste, water, and some areas of occupational health.

The Office of Technology Assessment, an instrument of the Congress, reported that in their case studies of the Superfund "there is evidence of significant problems in the quality of technical work". They concluded that "a shortage of experienced technical experts in several fields may explain a lack of quality performance now and it may cause a major bottleneck in an expanded Superfund program." They recommended that Congress fund education and training programs. This is a good example of how anecdotal information is used for policy formulation.

EXHIBIT 2.1: ESTIMATED NUMBER OF PROFESSIONALS EMPLOYED IN ENVIRONMENTAL AND OCCUPATIONAL HEALTH BY SPECIALTY CATEGORY, 1987

Specialty Category	Estimate Number
Total	109,000
Sanitarians	20,000[1]
Industrial Hygienists	11,000[2]
Occupational Physicians	3,000[3]
Occupational Nurses	29,000[3]
Occupational Safety and Health (Other than Industrial Hygienists and Medical)	26,000[3]
Other Scientists/Engineers and other (e.g., faculty and researchers) not included above (air, water, hazardous waste, etc.)	20,000[4]

Source: Bureau of Health Professions, Public Health Professions Branch Staff Estimates, 1987.

[1] This estimate is an "informed guess" made by the National Environmental Health Association.

[2] The Industrial Hygiene estimate is another "informed guess" made by the American Industrial Hygiene Association.

[3] The estimates for occupational physicians, nurses and related personnel are based on surveys and are fairly reliable.

[4] This estimate is a gross approximation made by estimating how many engineers and scientists in environmental protection are actually working in environmental health. We guessed that the estimates of 135,000 based on Census surveys of the 1970s have grown to 200,000 by 1987 and that environmental health constituted at least 10% of this group.

Several of the staff that prepared the reports to Congress are here at the workshop and will be glad to go over the details of these estimates with you during the next few days. They asked me to make a suggestion to simplify your tasks during the workshop - keep in mind that the total environmental health workforce is larger than that portion which requires basic occupational preparation in environmental health. The latter is probably easier to deal with and is the group in which the Bureau and the Public Health Service is most interested.

Let me close by saying that refining estimates of supply and requirements or evaluating the public health workforce by specialty area - air, water, food, hazardous waste - is even harder than determining the overall estimates of the total workforce as I discussed here.

I wish you well in your efforts these next two days. Your task is a tough, but important one. Good luck. Thank you.

3. KEYNOTE ADDRESS

Evaluating the Environmental Health Work Force

By
Larry Gordon
Secretary, New Mexico Health and Environment Department

I have been especially interested in the planning and development of this workshop. The need to come to grips with the nature, numbers and requirements of the environmental health work force is long overdue.

I cannot begin to discuss the environmental work force without recalling my first job as an entry level county sanitarian. I really didn't know what a sanitarian was. I was put to work at $255 per month after being given two days orientation with another sanitarian and being provided with inspection pads, a clip board and a thermometer. As I went to my appointed rounds, I frequently wondered what I would tell someone if they asked what I did and could only come to the conclusion that I "inspected." This was probably not an unusual state of affairs for a sanitarian in 1950.

I will refrain from dealing with any specific professional group such as sanitarians or engineers in this paper and use the opportunity to discuss the field of environmental health. A number of definitions have been utilized for various conferences and publications, but I have no trouble in utilizing the definition which the staff for this workshop has selected. This definition of environmental health reads as follows: "The systematic development, promotion and conduct of measures which modify or otherwise control those external physical factors in the indoor and outdoor environment which might cause illness, disability or discomfort through interaction with the human system. This includes not only health and safety factors, but also aesthetically desirable conditions in accordance with community demands and expectations."

The field of environmental health includes such programs as water quality, air quality, radiation protection, occupational health and safety, food and milk protection, noise pollution control, hazardous material management, housing conservation and rehabilitation, solid waste management, water supply protection, insect and rodent control, and institutional environmental health, and recreational area health and safety. All of these program areas have a health goal as a minimum, although they may also address quality of life factors. Personnel are involved in such activities as inspection, standards development, research, planning, epidemiology, risk assessment and biostatistics. All of these measures are part of the previously quoted definition of environmental health which modify or otherwise control factors in the environment which impinge on human health. A wide variety of professions are essential to this effort, including natural scientists, physical scientists, medical scientists, attorneys, public health professionals, planners, statisticians, meteorologists, computer scientists and others too numerous to mention. All are essential to the comprehensive field of environmental health.

At this point in my discussion, I find it necessary to note a basic and important distinction between the terms "environmental health professionals" and "professionals in environmental health." Professionals such as geologists, engineers, biologists, physicists, computer scientists, food technologists, chemists, toxicologists, geo-hydrologists, planners, economists, attorneys, statisticians, epidemiologists, risk management scientists and many others are essential to the field of environmental health, but they are not necessarily environmental health professionals. They are professionals in environmental health. Environmental health professionals, on the other hand, have been educated, at a minimum, in the major components of environmental health and in the basic public health sciences of epidemiology and biostatistics. Both environmental health professionals and other professionals in environmental health are utilized at all levels of government as well as in academia, industry and citizen groups. Most environmental health professionals are products of accredited schools of public health or accredited environmental health programs outside schools of public health. I firmly believe that most, if not all, environmental health professionals are produced by undergraduate and graduate programs accredited by the Council on Education for Public Health or the National Council for the Accreditation of Environmental Health Curricula. Other programs are graduating personnel such as environmental scientists who may become professionals in environmental health. Most non-accredited environmental science programs do not require the core public health sciences.

Accurate figures for environmental health expenditures and personnel have never been obtained and use of systems that report only a fraction of the total can be very misleading. In fact, when used in reports to Congress, such data can even be damaging to the field. For example, the annual report of the Association of State and Territorial Health Officials provides information on only a portion of the environmental activities in states. I have tried unsuccessfully on numerous occasions to convince them to expand the system beyond official health agencies with no success; but as an example, I will quote from a letter I wrote in 1982:

The National Public Health Personnel Reporting System (NPHPRS) reports those programs within the jurisdiction of each state's designee to the Association of State and Territorial Health Officials (ASTHO). Many, perhaps most, states have more than one health agency although only one may actually have the title of something like `state health department'. Inasmuch as each state's designee to ASTHO is usually the chief executive officer of the health agency bearing such a title, it is conceivable that more activities go unreported than are reported in some states. In my own state, for example, the official designee to ASTHO prior to 1978 was the Director of the Health Services Division. Inasmuch as the Health Services Division only has responsibility for personal health programs, all of New Mexico's programs relating to mental health, drug abuse, alcoholism, laboratories and environmental health were left unreported. In 1978 I recommended that the Secretary of the Health and Environment Department, rather than the Director of the Health Services Division, be the official representative to ASTHO. This had the effect of requiring reporting not only of the Health Services Division, but also of our Environmental Improvement Division, Health Planning and Development Division and Behavioral Health Services Division. The expenditures reported for New Mexico immediately increased five-fold by merely changing our representative to ASTHO.

As you know, many (probably the majority) of states have created EPAs separate from the official state health agency. All of the programs administered by these EPAs are basic health programs and, perhaps more importantly, disease prevention programs. Similarly, I believe my department is the only health agency in the nation operating a fully comprehensive occupational health and safety program. In most states, occupational safety and health programs are administered by departments not bearing a title including the term health.

Not only do the preceding situations place serious limitations on the expenditures and activities reported by NPHPRS, but also seriously skew the relative percentages of health expenditures and activities reported by NPHPRS. It is conceivable that some states may spend more for either environmental health or behavioral health outside the official state health agency than for personal health within the official state health agency. The amount of funding attributed to prevention might be significantly increased if these health activities were reported.

The NPHPRS also attributes some 37 percent of environmental health program expenditures to consumer protection and sanitation. If the health programs outside official state health agencies were reported, the leading expenditures would undoubtedly be air quality, water quality and, perhaps, waste management. Assuming that there is some relationship between health program reporting and educational needs, expenditures and projections, the NPHPRS also would tend to skew these figures.

Other forces also seem to be at work to damage or retard the quality and supply of environmental health practitioners from schools of public health. One of these is the parochial attitude that schools of public health should produce graduates for "health agencies," while denying that environmental health programs in agencies termed pollution control, environmental quality, ecology, atomic energy, labor or environmental protection are also health programs having health goals and would not be in existence except for these goals.

Second, concurrent with increased expenditures in our nation's health care (treatment) system, schools of public health continue to increase emphasis on health care at the expense of public health (prevention) programs including environmental health.

Third, faculty in schools of public health as well as environmental health programs outside schools of public health are frequently offering curricula with which they are personally comfortable rather than addressing the priority needs that are emerging in the field. Too often, environmental health agencies (whatever their titles) are involved, not in prevention, but in curative efforts to solve problems created due to decisions made by other agencies or at other levels of government. Only when environmental health agencies have professional personnel capable of effectively addressing the public health impacts of land use, alternative energy systems, transportation and resource consumption at the initial planning stages prior to the decision-making stage, will environmental health become preventive rather than curative. The importance of those efforts must be emphasized both by the schools and the hiring agencies. But even these skills will not be fully effective until society can ameliorate problems of ignorance and poverty.

Fourth, several recent appointments of non-public health professionals as deans or department chairs of schools of public health suggest that some schools are more interested in pursuing the almighty research dollar than educating public health practitioners. As an example of this trend, I quote from a letter I wrote to the University of Michigan School of Public Health in 1985.

Obviously, the new environmental health chair at the University of Michigan School of Public Health will not only set the tone and affect the reputation of the environmental program for many years to come, but more importantly, will have a significant impact on the quality and quantity of environmental health leaders and programs providing service to the public in the United States and throughout the world.

It is essential to note that the chair must be above all, a visionary environmental health leader with a keen public health philosophy. More importantly than being a researcher, this leader must have the reputation and experience necessary to attract faculty and students to whom serving people is a high priority. The chair must have the vision necessary to look to the future and insure curriculum and educational content appropriate to the people needs of the future. Hopefully, the need for research funds will not outweigh these more important characteristics.

Of equal or greater importance than scientific research ability, our environmental health leaders and your department chair should be extremely knowledgeable and effective in developing and implementing public policy, the political process and comprehensive management skills. Public health leaders must be able to translate the results of research into effective public policy at the Federal, state and/or local levels.

I am increasingly concerned that schools of public health are more interested in faculty research than providing student education and community service, and ultimately insuring quality professionals, programs and public service by official agencies, industry and professional and voluntary groups.

For many years, I was impressed and proud to observe that University of Michigan alumni held key leadership positions in public health throughout the world. Those leaders in attendance at most key national public health policy gatherings were disproportionately representative of University of Michigan School of Public Health alumni. For many years, University of Michigan School of Public Health alumni practically monopolized leadership positions in national professional groups, such as the American Public Health Association. This situation has been deteriorating coincidentally with the increasing emphasis on research funds over the past few years. Educating tomorrow's leaders has become secondary to grants, contracts, student enrollment numbers and faculty size.

Environmental health priorities of the future will continue to include air and water pollution, solid wastes, radiation protection, toxicology, toxic chemicals, occupational safety and health, hazardous wastes, food protection and water supplies. But to be more effective, of greater service and engaged in a preventive rather than a curative mode, future leaders must have the requisite knowledge to effectively address the environmental health impacts of population numbers and distribution, resource consumption and conservation, alternative energy resources, land use and transportation methodologies.

Fifth, environmental health graduates must have adequate knowledge of public policy, public health risk assessment, cost-benefit analysis and the political process and be able to bridge the gap between scientists and elected and policy makers. I do not wish to imply or suggest that schools and programs have not changed. They have changed significantly to meet changing problems and priorities and to effectively utilize the latest techniques and knowledge.

Changes have been created by the changing environmental health problems, changing societal values and expectations, changing environmental health priorities and the emergence and development of a vast array of environmental health programs, organizations and institutions. I have no doubt that students and graduates are more knowledgeable and mature than ever before. Students are demanding educational relevancy to a greater extent than in the past, and this pressure continues to have some effect on the educational curriculum.

It is obvious to everyone that the complexity of the total environmental health delivery system is increasing, resulting in needs and demands for different types of personnel. Some recognition has also been given to the premise that improved managerial skills will improve the effectiveness of the environmental health delivery system.

The changes in health problems which have been accompanied by changes in curriculum include decreases in communicable diseases as major causes of death; the aging of our population with associated increases in a multitude of chronic diseases; changing lifestyles relating to exercise, obesity, smoking and nutrition with their implications for public health; and increased recognition of the relationship between the environment and cancer, heart disease and genetic diseases. The increasing realization that the best answer to public health problems lies in prevention has had and will continue to have an effect on the environmental health curriculum.

Environmental health person-power requirements include not only those working in and managing such programs, but also those academicians producing such person-power and those research scientists developing the necessary health knowledge base. The spectrum of such person-power ranges from inspectional level subbaccalaureate personnel doing routine inspection and sampling through the baccalaureate, master and doctoral levels required for the more complex aspects of policy, management, research and education.

Programmatic and academic efforts should be based on sound epidemiology and risk assessment. We should give greater consideration to priorities based on years of productive life lost rather than on causes of death. Utilizing epidemiology or risk assessment for public health policy guidance would refocus future programs to have the greatest impact on overall health status and environmental quality. We would also learn that we should not be decreasing efforts on problems of the biological environment (such as food protection), and that the required additional emphasis on problems of the chemical environment should not be at the expense of the biological environment. These are issues which are still of importance when utilizing the tools of epidemiology and risk assessment for focusing environmental health policy.

Arguments about the need for specialists vs. generalists are nonproductive and inane. Both are needed now and in the future. The generalist is perhaps more suited for management, while specialists are essential for the various specialized branches of environmental health.

There continues to be a gap between town and gown. While some environmental health educational programs and operating programs have excellent, continuing communication, many still operate in comparative vacuums. Town and gown work best together through organized mechanisms rather than leaving communication to chance and personalities.

The career heights to which professionals in environmental health and environmental health professionals may aspire are as great as the individual's capabilities and desires. While it was once assumed there was a career ceiling over professionals in environmental health, time and experience have proven that individual capabilities equal those in other professions. There is a solid record of achievement in government, academia, industry, professional organizations and community service. There are directors of health, directors of environmental health agencies, professors, deans, industry and association executives and various other managerial and executive capacities listed within the ranks of environmental health personnel. Environmental quality is an important goal in our society, and protecting human health is an essential component of that goal. Capable environmental

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health personnel are necessary to achieve that goal. As a profession, we need not take a back seat to any other group. Any question of capabilities comes from negative attitudes rather than from the lack of expertise or the need for same. Environmental health personnel must realize their value and continue to aspire and achieve and be proud of their part in insuring a quality environment. Appropriately educated personnel will not insure resolution of all environmental health problems, but certainly resolution will be impossible without them.

The expertise gathered here will offer important recommendations and contributions to the issue of evaluating the environmental health work force. These contributions will be of great significance to all involved in education and utilizing environmental health personnel. The next few days will be informative and exciting for all of us.

4. SUMMARY OF COMMISSIONED PAPERS

Papers on the ten topic areas were commissioned from thirteen authors. The paper on Institutional Safety and Health and Radiological Health was written by two authors, while three authors wrote the Academician paper. In addition to writing the papers, the authors presented their highlights at the workshop. Below are summaries of the papers, the authors' presentations, and key points raised during the question and answer periods which followed the presentations at the workshop. The complete papers are available on request.

4.1 AIR

"Assessment of Work force Needs and Issues: Air Pollution and Noise Programs" by Ray Mohr, Air Pollution Control Division, Colorado Department of Health.

The work force in Air is concerned with three primary program areas: (1) mobile source air pollution control, usually automobiles; (2) stationary source, or industrial, air pollution control; (3) the collection of data to provide the technical support necessary for the first two areas. The large majority (80 percent) of workers in the field hold professional, technical or managerial positions. These include air scientists, engineers and technicians. Recently, agencies involved in air pollution control have employed other types of personnel, including epidemiologists, toxicologists, planners, statisticians and economists. It was suggested that in some states, epidemiologists and toxicologists are becoming increasingly involved in the establishment of standards; once the standards are set, engineers design the means to meet those standards.

The basic requirements for practice vary among the three primary classifications. Air scientists, who perform analyses and are involved in research and investigations, are usually required to hold a baccalaureate degree in a science -- biology, environmental health, meteorology, industrial hygiene, or public health. A graduate degree is required for research positions. Air engineers perform air monitoring and inspection activities and are required to hold a baccalaureate degree in engineering. Continued employment may require the Practicing Engineer (P.F.)

credential. Additionally, it was suggested that an increasing number of employers are requiring engineers to hold master degrees. Air technicians are responsible for the day-to-day operation of sampling and testing equipment and are required to have a high school diploma and some technical experience. In some cases, a two year technical education may be required.

Because of the lack of literature on the subject, the author contacted the Air Pollution Control Association, the Environmental Protection Agency, and several states to obtain information on the work force in Air. In addition, he conducted personal interviews and a telephone survey of air pollution control agencies. Based on the results, he estimated that there are between 6,000 and 7,000 environmental health personnel specializing in air pollution control in the public sector. Of these, 22 percent are engineers, 34 percent scientists, and 40 percent technicians. The remainder are managerial and support staff. Questions were raised concerning this estimate of the work force. Estimates developed at conferences of the EPA were somewhat larger than the 6-7,000 figure; however, those included the private sector. In addition, since membership in the Air Pollution Control Association is approximately 6-7,000, the total work force must be greater. It was suggested that the entire environmental health work force in air may be in the range of 20,000 - 26,000.

The primary forces which have affected the work force in this field are:

- Resource allocation to state air agencies under Section 105 of the Clean Air Act;

- State and local legislative and budget processes; and,

- Training and development support consistently applied to state and local agencies from the Federal government.

The major environmental health work force issues in Air are recruiting and training. Almost 90 percent of the agencies contacted by the author indicated that they were having difficulty recruiting qualified personnel. This was attributed to the agencies' inability to offer competitive salaries and to affirmative action guidelines. Training for new personnel and continuing education for existing personnel is greatly needed. When the EPA was established in 1970 and the Clean Air Act Amendments were first passed, the EPA offered a complete training program in Air. That program has almost disappeared, being replaced by self-study courses and the use of colleges and universities as area training centers. However, both the amount of funds awarded to the states by the EPA and the amount directed to training have been curtailed. The courses still available are sporadic and do not address the new areas of concern in the field, such as air toxins. These new areas are creating significant work force needs.

Noise control programs are small and relatively new. The National Environmental Policy Act of 1970 required assessments of the impacts of noise, while the Noise Control Act of 1972 gave the EPA the power to set noise standards. There are two primary occupational groups in this field. The noise engineer, whose duties are usually combined with other programs in air pollution or radiation, is required to hold a baccalaureate degree in civil, mechanical, aeronautical or acoustical engineering. The noise specialist, who undertakes environmental studies, enforcement or public education activities, is usually required to hold a college degree. Due to a lack of available data, the author was unable to estimate the size of the work force in this field.

EPA funding for programs in noise control ended by 1984; therefore, many states eliminated their programs at that time. There are probably significant work force and training needs; however, there is insufficient information available to determine the extent of those needs.

4.2 WATER AND WASTEWATER

"General Environmental Health Professional: Water" by John B. Conway, Associate Director, Graduate School of Public Health, San Diego State University.

The environmental health work force in water is concerned with water quality and water supply in the areas of: potable water, domestic water, recreational water and wastewater. In addition to state and local government agencies, personnel are employed by industry, consulting firms, academic institutions, and Federal agencies such as the EPA, the Department of Labor and the National Park Service.

Personnel in the work force fall into three primary categories. Environmental health technicians collect samples and perform supervised laboratory activities. They are required to have a high school diploma and two years of either technical training or general college courses. Environmental health professionals, or sanitarians, inspect systems and perform other water sanitation activities. They are usually generalists and are required to hold a bachelors degree in environmental health, any of the sciences, or engineering. Specialized environmental health professionals or scientists includes biologists, chemists, engineers, epidemiologists, environmental toxicologists, geologists, and others. They are required to hold bachelors degrees in their specialty areas. Some specialties, such as epidemiology, hazardous waste, and toxicology, require graduate training. In addition, other professionals involved in water activities are management and administrative personnel such as attorneys, planners and policy makers. Some positions in the field require credentialing in the form of licensure, registration, or certification.

Numerous academic institutions have programs in this field. There are 24 graduate schools of public health with approximately 400 new students per year in masters' and doctoral programs in environmental or occupational health. An estimated five to ten percent of these specialize in water. There are 23 undergraduate and four graduate programs in environmental health accredited by the National Accreditation Council for Environmental Health Curricula. Of the 1,500 to 2,000 students in these programs, roughly 100 are interested in water-related fields. In addition, there are many college and university programs in environmental health or environmental science that are not accredited but which graduate practitioners in the water field. The same holds true for accredited programs in engineering, biology, and other areas.

The author estimated the supply of water quality professionals by first approximating the number in the state of California and then extrapolating it to the United States as a whole. Based on data from the Chief of Local Environmental Health Programs and the Regional Water Quality Control Board, he determined that there were 600 full-time equivalent professionals employed at the state and local government level in California. To this figure he added individuals employed by water and wastewater treatment plants, consulting firms and the Federal government for a total of 1,000 practitioners. Since California has the largest population of any state, the author took half of this number and multiplied by 50 states for an estimate of 25,000 water quality and water supply practitioners.

Although demand in the field should remain relatively constant overall, there are shortages of personnel in selected areas. Practitioners with toxicological backgrounds who understand chemical reactions are in demand, as are those trained in hazardous waste and health risk management. At this time, these practitioners are trained on-the-job due to the lack of training in critical water skill areas by academic institutions. More highly skilled sanitary engineers, hydrogeologists and soil scientists will also be in demand in the future. In addition, practitioners should be specialists in such areas as epidemiology, aquatic biology or hazardous waste, rather than generalists, in order to meet the changes in the water area. A team which includes an engineer, toxicologist and epidemiologist will be best able to meet these demands. This will make it difficult for small local health departments to have the personnel necessary for water quality surveillance and it is doubtful that state agencies will be able to assume the responsibility.

4.3 MILK/FOOD

"The General Environmental Health Professional in Milk and Food Protection" by C. Dee Clingman, Vice President for Quality Control, General Mills Restaurants.

Food supply protection was one of the earliest functions of the sanitarian. Because of the complexity and diversity of the world's food supply, this function has global implications. Milk sanitarians are concerned with the protection of the product from its source, through production, to the consumer. The inspection of pasteurization and post-pasteurization processes are of particular importance. Unlike professionals in the milk area who are involved from the point of production, those engaged in food protection are usually concerned with the safety of the food supply only after it reaches the processor or retailer.

Environmental health professionals in areas such as air and water pollution control also affect the milk and food supply; however, this paper focused only on practitioners primarily interested in milk and/or food and primarily engaged in inspectional activities. Although many types of practitioners, including planners and managers, work in the field, sanitarians are the most prevalent. The majority are employed by state or local health departments. Others work for industry, academic institutions, and the Federal government. In recent years, due to the consolidation of the milk industry and lack of financial support, milk programs have shifted from local to state agencies. However, state support of food programs has been reduced so that they now must be supported more extensively by local health departments.

Prior to 1955, the majority of practitioners in the field were political appointees and had little or no education or experience in the area. Now the majority of agencies and industries require a baccalaureate degree for entry-level positions. In the milk industry, experience often substitutes for a college degree. A master's degree is usually required for supervisory positions. Registration requirements for sanitarians vary considerably among the states. As of 1984, 34 states required sanitarians to become registered in order to practice in the state; 16 states had no education or experience requirements.

The author estimated the size of the work force in milk and food protection to be between 13,500 and 14,200 full-time equivalent practitioners. His estimate is based on the assumption that, on the average, each of the 2,700 local and state health agencies in the United States employs four food and one milk sanitarian for a total of 13,500 individuals. In addition, he assumed that industry employs five percent or 200 of this number. The author assumed a three percent growth rate and five percent turnover rate to estimate that 1,200 new practitioners were needed each year. There appears to be an adequate supply of personnel in the area. However, the supply of individuals with degrees in environmental health is significantly less than the demand. Practitioners with these degrees are more likely to be found in industry because of the higher salaries. Due to salary structures and reduction of support of milk and food programs, the demand for practitioners has decreased in state and local governments but has increased in industry. Therefore, we often find that the regulatory level environmental health personnel are less qualified and less educated than the people they are regulating.

Overall, demand in the field is expected to rise because of the increasing complexity of the food supply, the growing internalization of the supply, and the emergence of new safety concerns regarding biological hazards. A question was raised concerning the issue of chemical contamination of the milk and food supply. Chemicals are often used in food production or protection for aesthetics and cannot, therefore, be easily banned. These issues have resulted in a demand for more specialized training as the "generalist" is no longer able to adequately manage food and milk programs. However, training in the area is not readily available. It was suggested that a "Food Protection Academy" be established to provide complete coursework, particularly in food protection. Other issues that impact the work force, in addition to salary inequities at the state and local level, are a lack of upward mobility and the absence of a recognition system.

4.4 LAND USE PLANNING AND MANAGEMENT

"Work force Status and Outlook in Environmental Health Land Use Planning and Management: The California Experience" by Richard Roberts, Director, San Bernardino County Department of Environmental Health Services, with assistance from Paul Ryan and Clifford Williams of his staff.

Environmental land use planning and management practitioners were defined as "professionals qualified by education and experience to review land use proposals for the purpose of assessing environmental impacts and evaluating health risks, and recommend actions that will protect the public from exposure to disease and other health and safety hazards; and, to protect the environment from degradation." Practitioners must coordinate a comprehensive multidisciplinary solution to complex development, growth and infrastructure problems as well as those related to such current issues as industrial facility siting, landfills, or solid and hazardous waste disposal facilities. Workshop participants suggested that professionals in this area are those that facilitate and coordinate activities rather than those that do the actual planning. This is not necessarily the case with smaller local agencies. The large majority of practitioners work at the local level, although there is substantial information exchange between the private sector and state and Federal agencies.

The work force in this area is compared primarily of sanitarians or environmental health scientists, engineers, and planners. The entry level academic standard is usually a baccalaureate degree in environmental health or basic science, geography, urban planning, or engineering. For the most part, at least four years of experience are necessary in order for a practitioner to become proficient in the field. California has registration programs for both the sanitarian and engineer to ensure minimum education, experience and training requirements. There is no required credentialing program for planners in the state.

The author estimated the supply of land use planning and management professionals in California based on information from the State Department of Health Services, the State Board of Engineers, and the California chapter of the American Planning Association. He estimated that there were a total of 250 public sector practitioners in California, with an additional 250 in the private sector. Extrapolating this to the rest of the country, based on the fact that about 10 percent of the population resides in California, gives an upper estimate of 5000 practitioners nationwide. As California legislation in this area is different from that in the majority of states, a lower estimate of 3000 practitioners nationally may be more accurate.

A questionnaire was distributed to land use planning and management professionals through the Association of Environmental Professionals and the Center for Environmental Intern Programs, Inc. to determine the adequacy of the work force. Approximately half the respondents worked in the public sector and half in the private sector. It was felt that there was a minor shortage of personnel. Private sector respondents were more likely to think that supply and demand would increase in the future than those in the public sector due to the general public's growing interest in hazardous waste facilities and waste-to-energy projects.

The respondents felt that certain key functions were currently not being performed by practitioners in the field and that there was a lack of understanding of environmental regulatory programs, interface between the scientific community and practitioners, ground water contamination and hazardous materials assessment and mitigation studies, and implementation and compliance activity for mandated programs. These problems are related to a shortage of qualified individuals and to educational needs. The most significant educational issues concern a lack of practical knowledge by entrants and the need for greater interdisciplinary education. A solution would be a combination of education and field work or internships.

The author recommended that environmental health science be linked with environmental studies programs at the university level. In addition, he suggested that the Association of Environmental Professionals, the National Environmental Health Association and the American Planning Association be linked to further study this area, establish a national clearinghouse for work force data, and establish a credentialing mechanism.

In response to a question at the workshop, the author said he preferred to hire a good generalist in environmental health. He then spends six months training the person to meet agency needs. This system has reportedly worked well for his agency.

4.5 OCCUPATIONAL SAFETY AND HEALTH

"A View of Occupational Health Manpower: Present and Future" by David Fraser, Department of Environmental Sciences and Engineering, University of North Carolina, Chapel Hill.

This area differs from many in environmental health in that employers are well identified. Practitioners are trained in engineering or the sciences, but only those with a health focus are included in the environmental health work force. This definition includes industrial hygienists, occupational health physicians, occupational health nurses, and occupational safety practitioners. This paper focused primarily on the industrial hygienist.

The responsibility for injuries and illnesses in the workplace was first placed on the employer in 1911 with the enactment of the first workmans compensation laws. This responsibility has been emphasized with the Occupational Safety and Health Act of 1970 and the Hazard Communication Act. Recently, Congress passed legislation requiring employers to inform employees of potentially hazardous exposures. Occupational physicians and nurses were first employed by industry to address these needs and reduce liability costs. As it became evident that the solution may often be preventive rather than curative, the skills of industrial hygienists and occupational safety practitioners were sought.

Although in the past almost any employee might be assigned the role of industrial hygienist regardless of background or training, in recent years steps have been taken to ensure a qualified work force. The American Board of Industrial Hygiene certifies practitioners by examination. Five years of creditable experience is usually required, although graduate education can be substituted. It is expected that, because of increased litigation in the field and an increased employer sensitivity, certification will become required for practice in the field.

There are approximately 40 educational institutions offering formal training in industrial hygiene. Of these, 27 have been awarded training grants by the National Institute of Occupational Safety and Health (NIOSH) to establish or maintain educational programs. Another 14 are parts of Educational Resource Centers supported by NIOSH to provide training in the four core disciplines of occupational safety and health. In 1986, the Educational Resource Centers enrolled 544 students in industrial hygiene programs. An additional 113 students were enrolled in the 27 programs with NIOSH training grant support. These programs graduated a total of 171 students, with 225 graduates expected in 1987. The Educational Resource Centers produced fewer graduates in the other disciplines: 63 in Occupational Medicine, 61 in Occupational Nursing, and 29 in Safety. Data are not available on the remaining industrial hygiene programs. However, the author estimates that they graduate fewer than 50 students each year. NIOSH requires that the programs it supports maintain certain standards. Currently, however, there are no national standards for all training programs in the field. The American Industrial Hygiene Association (AIHA), though is moving to develop an accreditation board for programs in industrial hygiene.

In estimating the supply of industrial hygienists, the author made the assumption that the 8,000 members of AIHA represented 80 percent of the work force in the field, for a total of 10,000 individuals. AIHA confirmed this figure in their own estimates of the work force based on membership in its local sections and in the American Conference of Governmental Industrial Hygienists. Recent growth rates in the field suggest that the industrial hygienist supply might increase to 11,500 - 12,500 by 1990. As the supply of and demand for industrial hygienists are sensitive to political and economic factors and to the proliferation of legislation in the area, it is expected that the need for industrial hygienists will continue to increase. It is clear that educational programs will require increased Federal support in order to meet this need.

4.6 HAZARDOUS MATERIALS

"Work force Status and Outlook in Hazardous Materials Management" by Richard L. Wade, Executive Vice President, Med-Tox and Associates, Inc.

Hazardous materials management is defined as the control of potentially hazardous materials from "the point of extraction of raw products to their elemental destruction, transformation into non-hazardous materials or disposal in controlled facilities." The field is regulation-driven in that many steps are taken in order to comply with government regulations and to protect businesses from liability. At the Federal level, regulations include those implementing the Safe Drinking Water Act, the Hazardous and Solid Waste Act, the Resource Conservation and Recovery Act, and the Superfund.

The responsibilities of practitioners in this field vary among employers. Those employed by the public sector are required to have skills related to regulation interpretation, program administration, monitoring, standard and criteria development, and general understanding of treatment options. Practitioners in the private sector need less knowledge of the regulatory process but, instead, are required to have strong skills in engineering, treatment technology design, and some business training. In other words, the public sector needs scientists whereas the private sector needs engineers.

Many professional job categories are found in hazardous material management. These include industrial hygiene, chemical engineering, environmental engineering, toxicology, geohydrology, and quality assurance/quality control. The author stated that a hazardous materials management specialist is not necessary. Rather, the skills of the practitioners listed above must be matched to the needs of individual businesses or government agencies. For the most part, employers hire new industrial hygiene or engineering graduates and then train them specifically for work in hazardous materials. However, core curricula in hazardous materials at the graduate level as well as specialized two to five day training courses are required to ensure a qualified work force. The Superfund Amendments set aside $10 million for developing these much needed training programs. It was suggested that a catalog of training courses be developed to aid employers in locating available courses in specialized areas.

There is little or no quantitative information on the work force in hazardous materials management. The author estimates that there are currently 40,000 - 70,000 professionals in the field. Approximately 40 percent of these are employed by government agencies with the remainder in the private sector. The average large company employees 3.4 staff to control hazardous materials. Based on the results of a Region IV survey, the approximately 100,000 large private firms in the U.S. would create a estimated demand by 1990 for 42,000 hazardous materials management professionals. The EPA estimated that manpower needs may rise from under 4,000 in 1985 to 21,000 by 1995 for the clean up of uncontrolled sites.

4.7 INSTITUTIONS/RADIOLOGICAL HEALTH

4.7.1 Institutional Safety and Health

"Environmental Health Work force Demands: The Institutional Environmental Health Scientist" by Joe E. Beck, Director, Environmental Health Program, Western Carolina University.

Institutional environmental health scientists are educated in the sciences and trained in the health implications of the environment in order to control the physical, biological, and chemical hazards to human health in institutional settings. These professionals are employed "in-house" by schools, hospitals, jails, day care facilities, and other similar institutions. Individuals employed by state or local health departments to perform routine nursing home or other inspections are not included in this practitioner category. The need for professionals in this field was created in part by the reaction of the insurance industry to the bankruptcy of several national corporations recently because of environmental problems.

Various specialists are employed in this field, including safety officers, industrial hygienists, infection control managers, laboratory safety specialists, hazardous waste managers, and biohazard control officers. Larger institutions may employ a wide range of these specialists; however, most institutions are unable to afford specialists and require a generalist with some skills in these areas who can set up and manage a comprehensive program to ensure health and safety.

A broad-based interdisciplinary education at the baccalaureate level is required for entry in this field. Coursework should include toxicology, epidemiology, injury control principles, hazardous materials management, and program/project administration. Currently, only the twenty-three undergraduate and four graduate programs accredited by the National Accreditation Council for Environmental Health Curricula and the 24 accredited Schools of Public Health can be verified as meeting minimum educational standards for training in institutional safety and health. Continuing education is particularly important as an individual moves from a specialist to a generalist manager role. It should include courses to increase competency in environmental health and multidimensional courses to meet the specific needs of the institution. The author felt that five years of experience, including a year each in supervision and administration is necessary because of the complexity of the field. There is currently no credentialing program specific to institutional safety and health. However, three associations, NEHA, the American Academy of Sanitarians, and the Society of Environmental Health Scientists, credential generalists in environmental health.

The author estimates that 10,000 to 12,000 professionals are currently in demand in this field. Many of these positions are now filled by persons without a proper educational background or comprehensive training. Need was estimated based on the institutional settings. Each of the nation's 2442 schools systems, 2500 higher education institutions, 7000 acute care facilities, 350 Federal and state correctional facilities, and 2400 county-wide institutions is felt to need at least one institutional safety and health professional. Larger facilities or systems would, of course, require more positions. Thus, current need is estimated to be at least 15,000.

Current demand for institutional environmental health scientists can only be met at the expense of employers in other areas unless educational programs can prepare an increased number of individuals. The author recommended that training be provided to bring those currently employed in the field "up to par". In addition, enrollment in programs at the undergraduate and graduate levels must be encouraged. Federal funds are required for this. In addition, role models for a comprehensive institutional safety and health program should be developed.

4.7.2 Radiological Health

"Work force Status and Outlook for Radiological Health Personnel" by H. Harold Lehman, Center for Devices and Radiological Health, Food and Drug Administration, U.S. Public Health Service. Presented at the conference by Leo Snyder of the Public Health Service.

Radiological health is concerned primarily with the harmful aspects of and unnecessary exposures to ionizing forms of radiation. The majority of professionals in the field are health physicists; thus, the paper focused on this group. Health physicists are employed by Federal agencies, including the Nuclear Regulatory Commission, Department of Energy, and the Food and Drug Administration; state health departments or environmental control agencies; universities, hospitals and medical centers, and various industrial facilities, including nuclear power plants. The nuclear power industry employs the greatest percentage of practitioners.

Practice in radiological health usually requires basic education in the physical sciences. Other disciplines include public health, engineering, biology, chemistry, electronics, and medicine. For practitioners involved in food or water sampling and analysis activities, a broader background in environmental health is required. In order to be certified by the American Board of Health Physicists, health physicists must hold a baccalaureate degree in physical science or engineering and must have six years of experience in health physics. Employment by state agencies usually requires a Bachelor of Science or Master of Science degree with three to five years of experience in the field. Medical facilities and the nuclear industry are more likely to require a master's or doctoral degree.

Estimates of the supply of radiological health practitioners range from 6,000 to 12,000 individuals. Data on employees of state agencies are collected by the Conference of Radiation Control Program Directors. For FY 1985, data on 1,000 personnel showed that two-thirds are at the professional level and the remainder are technical and support personnel. Only 7.8 FTE's are involved in non-ionizing programs.

Although there has been a dramatic reduction in the number of nuclear reactors built in recent years, radiological health personnel demand is strong. The largest area of growth is associated with medical and research institutions due to new legislation and technology in the field. The increasing problem of radioactive waste handling and disposal is also affecting demand.

Enrollments in education programs, particularly at the doctoral level, have declined in recent years because of curtailed Federal financial support. Schools of public health have also reduced programs in radiological health due to a lack of funding. However, prior emphasis on specialization and credentialing in the field has declined in recent years because of the reduction in nuclear power plant construction. In order to meet the more stringent standards being established and deal with new areas of concern such as radon, industry must assume a more active role in the education of radiological health practitioners.

4.8 SOLID WASTE MANAGEMENT, HOUSING, VECTOR CONTROL, AND NONWORKPLACE INJURY CONTROL

"Work force Status and Outlook for General Environmental Health Professionals Responsible for Solid Waste Management, Housing, Vector Control, and Nonworkplace Injury Control" by George A. Kupfer, Director, Bureau of Consumer Protection and Environmental Health, Milwaukee Health Department.

These areas are usually the responsibility of sanitarians in state or local health departments who spend a portion of their time in each area. The work force consists of professionals and technicians with a wide variety of backgrounds and training experiences. Although graduates of environmental health programs are usually desired, employers accept a range of other backgrounds. Due to the diversity of titles, location in a variety of departments or agencies, the responsibility for several program areas by a single individual, and a lack of data, it was difficult to estimate supply, demand and needs. For each area, the author surveyed agencies in five states and extrapolated based on population to the United States as a whole. In all cases, only personnel involved in preventive public health activities were included.

Solid waste management consists of the planning, administration and regulation of the storage, transportation and disposal of solid wastes. Practitioners are found at all levels of the public sector. In the past few decades, responsibility for this work has shifted from the local level to the states, which have assumed the primary role in enforcing Federal regulations. In addition, consulting organizations and private industry utilize sanitarians and scientists for the control of solid waste. The author estimated that there are 3,500 full-time equivalent (FTE) professionals and 8,000 FTE technicians currently employed in solid waste management. These figures include only those personnel with a focus on public health, not those responsible for surveillance or trash pickup. This work force is not expected to expand. There is, however, a need for training of existing professional and technical staff. Employers are expected to seek to replace staff with individuals with more technical training in toxicology, epidemiology, chemistry, biology and engineering.

Housing inspection programs vary considerably among states and local communities. Generally, most states and large communities regulate hotels, motels, rooming houses, and residential housing. Many use the model code developed by the American Public Health Association in 1952 as the basis for their regulations. Housing regulation involves activities in zoning and occupancy approvals, community planning, public education, elimination of nuisances, and inspection. Few programs have comprehensive regulations related to safety and injury control. The current supply of FTE professionals in this field is estimated to be 4,000, with an additional 8,000 technicians. The number of professionals may decrease slightly in the future; however, new areas of concern such as indoor air pollution and toxins will create a need for individuals with training in toxicology and epidemiology. Persons with industrial hygiene backgrounds will also be sought.

Vector control programs in health departments may focus entirely on the traditional control of rodents, or they may be expanded to include the control of insects, birds, wild and domesticated animals, snakes and other vectors. In addition to employment at all levels of government, personnel in this area are also employed by private industry. The author estimated the current work force to be 6,000 FTE professionals and 20,000 FTE technicians. Due to decreased community resources and the lack of readily apparent problems in this area, there is currently a trend to reduce staffing. However, in the long run this will lead to increased problems and a need for more personnel. The increased use of toxic chemicals to control vectors will have a large impact on the work force by creating a need for an expanded knowledge of chemistry, toxicology, and the concepts of epidemiology used in surveillance and enforcement.

Non-workplace injury control is a relatively new field. It can include the control of vehicle-related injuries, injuries caused by unsafe environmental conditions in public places or private residences, and injuries caused by chemicals, toys or food. The extent of programs in government jurisdictions varies considerably, from those that are purely educational to those that develop standards and regulations to prevent injuries. Very few local health departments have comprehensive programs in this field. Interest in the field at this time is greatest at the Federal level and in large, heavily populated areas. The current supply of practitioners in injury control was estimated as 900 FTE professionals and 2,000 FTE technicians. A quickening of demand for individuals trained in environmental toxicology, chemistry and toxicology is predicted.

An attempt was made to describe and estimate the work force in consumer protection and safety. However, the lack of an adequate definition for this field made estimation impossible.

In general, the author felt that there is a need for graduate level environmental epidemiologists and toxicologists. He expects this need to increase over the next few years, particularly at the Federal and state levels and in local health departments. Continuing education to upgrade the current work force is also required. Individuals specifically educated in chemistry, environmental toxicology and environmental epidemiology will be most eagerly sought. In the meantime, those with backgrounds in industrial hygiene will be hired to replace those leaving the current work force.

4.9 RISK ASSESSMENT/ENVIRONMENTAL TOXICOLOGY/ENVIRONMENTAL EPIDEMIOLOGY

"Training a Work force in the Fields of Environmental Toxicology, Epidemiology and Risk Assessment" by Christopher Schonwalder, National Institute of Environmental Health Sciences.

The National Institute of Environmental Health Sciences (NIEHS) supports programs under the National Research Service Awards Act for doctoral and post-doctoral training in environmental toxicology, pathology, mutagenesis, and epidemiology and biostatistics. Because of this, NIEHS maintains data on the work force in these specialties.

Environmental toxicology is the study of the processes by which environmental agents affect biological systems and by which the biological systems react with and influence the action and fate of toxic agents. The primary focus of toxicology is on hazard assessment and safety evaluation. Toxicologists are certified primarily by the American Board of Toxicology which requires either a doctorate and three years of experience or a master's degree with seven years of experience. The Academy of Toxicology Sciences also certifies toxicologists.

The supply of environmental toxicologists has been estimated to be approximately 5,000. Need estimates have varied substantially among various studies. The most recent study indicated a need for an additional 1,000 doctoral-level toxicologists and 2,000-3,000 with undergraduate degrees. The need for an increased number of professionals in this area is based on:

- An increased emphasis in the past decade on workplace safety and environmental quality; and,

- The passage of the National Environmental Policy Act (1969), the Clean Air Act (1970), the Occupational Safety and Health Act (1970), and, particulary, the 1976 Toxic Substances Control Act.

Environmental epidemiology is the "study of the relationship of environmental factors to the occurrence of mental and physical disease, including adverse reproductive outcomes, in human populations." Unlike general epidemiology which works "backwards" from a disease to determine the causal factors, environmental epidemiology begins with exposure to an environmental agent and then determines if there are adverse health effects. This requires in-depth knowledge of biomedicine. Environmental epidemiologists are certified by the American College of Epidemiology.

Estimates of the supply of epidemiologists in several studies have been based on the number of degrees awarded, primarily by schools of public health. The most recent of these, completed in 1985 for the Centers for Disease Control, estimated that 450 degrees were awarded annually. For the most part, the literature suggests that there is currently a shortage of epidemiologists and that this shortage is likely to increase in the future. The 1985 CDC study estimated that the demand for epidemiologists in 1988 would range from approximately 5,500 to 7,500. In 1984-85, NIEHS conducted a manpower study to determine the supply, demand and needs for environmental epidemiologists at five distinct training levels. That study indicated a market balance for terminal master's, doctoral (no prior M.D.) and postdoctoral training levels in 1988, 1987 and 1986, respectively; however, NIEHS felt that these data might not be accurate.

A question was raised concerning the difficulties of NIEHS in estimating the supply of and demand for what are possibly the most well-defined areas in the field of environmental health. Most of the difficulty resulted from an over-optimism on the part of university personnel as to the number of graduates that would be produced in the future. There were also problems in separating environmental epidemiologists from general epidemiologists. In addition, the political and economic climate existing at the time estimates are made greatly influence those estimates. For example, in 1980 there was a shortage of research toxicologists; however, it was felt that by 1985 all of the positions in industry would be filled. This was due to the political retrenchment and problems at EPA at the time. NIEHS currently tracks toxicologists and finds that demand continues to exceed supply.

Although risk assessment is a new specialty in environmental health, its processes have been used by environmental toxicologists and epidemiologists for many years. Risk assessment models are developed by practitioners to show the association between exposures and disease and to quantify that exposure in terms of dosages. The models are mathematical expressions of the chances of disease occurrence with various dosages. Because the field is so young and does not have a well-defined work force, the author was unable to estimate its supply and demand. However, at least in the near future, work in this area will primarily be done by environmental toxicologists and epidemiologists.

4.10 ACADEMICIANS

"Work force Status and Outlook for Environmental Health and Science Academicians" by Gary Silverman, Bowling Green State University (undergraduate programs), Ann Anderson, Tulane University School of Public Health (graduate programs in schools of public health), Trenton Davis, East Carolina University (graduate programs outside schools of public health), and Amer El-Ahraf, California State University (team leader and editor).

Of the 400 to 450 undergraduate programs with "environment" in the title, approximately 30 could be considered to have a health focus. This figure was based on the results of a limited phone survey of programs. However, as the Council on Accreditation of Undergraduate Curricula and Graduate Curricula has accredited 75 percent of this number, the author acknowledges that his estimate may well be low. The National Environmental Health Association lists the total number of programs as 64. The uncertainty regarding the number of undergraduate programs is caused primarily by definitional problems.

Based on the phone survey, there were an estimated 100 to 150 full-time equivalent faculty positions in undergraduate programs. The estimate was complicated by the fact that environmental health programs may use faculty from other disciplines and that environmental health faculty may teach in other programs or at different program levels. A doctoral degree is preferred for faculty in the area; however, field experience and national certification in an area of specialization are also important. Relatively few faculty hold degrees in environmental health. Currently, the demand is highest for individuals with backgrounds in industrial hygiene.

Undergraduate programs tend to rely heavily on part-time faculty working in the field of environmental health. This helps keep programs up-to-date with new technologies and issues in the field. In addition, a large number of the programs have internships to provide students with practical experience.

There are currently 24 schools of public health in the United States. Each provides annual information on students, faculty and expenditures to the Association of Schools of Public

Health. Therefore, this is one area in which data are readily available on the work force. Based on 1981 data on 21 schools, of the 9000 students enrolled overall, approximately 1300 were specializing in environmental or occupational health. There were about 425 graduates in these areas.

Data from 1985-1986 indicate that 23 of the schools employed 302 faculty in environmental and occupational health. Contrary to undergraduate programs in environmental health, almost 90 percent of these faculty were employed full-time. The most prevalent terminal degree among faculty is the Ph.D. Although additional credentialing is usually not required for employment, a number of faculty members hold national certifications. Unlike those in most other programs in schools of public health, very few faculty in environmental or occupation health hold joint appointments.

There are significant constraints in developing teaching programs to support the important emerging areas in the field of environmental health. The lack of financial support for faculty and curriculum development, particularly since the decline in support from the Bureau of Health Professions, is particularly important. The schools' emphasis on research, rather than service activities and practice in environmental health, is also a hindrance.

As with undergraduate programs, there are no data concerning the specific number of graduate programs in environmental health outside schools of public health. Only four programs are currently accredited by NEHA. A 1980 study listed 36 programs. On the average, these programs enrolled 65 students and graduated 12 students each year. The majority conferred the master's degree, half offered a doctoral program. There was little information regarding faculty. Thirteen graduate programs outside schools of public health were included in a 1985 survey by NEHA. These programs employed an average of 5.7 faculty members. Almost 30 percent held doctorates in environmental health and over half had field experience.

An additional study of graduate programs outside schools of public health was conducted by Hatlin of the University of Washington School of Public Health and Community Medicine in 1986, as a follow-up to the 1980 study of 36 programs. Only those programs which met the following definition were included: they must have a public health focus, award at least one graduate degree each year, have actively enrolled students, and be outside schools of public health. Of the 36 programs that responded, only 15 met the criteria. On the average, these programs had nine full time faculty members and enrolled 37 students. The obvious lack of data on these programs made it impossible to determine faculty supply, demand, and need.

In general, at all academic levels, workshop participants felt that training was an important issue. Courses in emerging fields such as risk communication and hazardous materials management, as well as in the more traditional areas of environmental health are needed. In addition, it is essential that educational programs "keep up" with new technologies and issues in the field. However, faculty members reminded participants that only a finite number of courses could be taught at any one level due to the limited number of credit hours available. It was also suggested that the purpose of undergraduate programs was to educate students generically and not necessarily in environmental health, whereas education at the graduate level could be viewed as specific job preparation in environmental health.

5. SUMMARY OF WORKGROUP POSITION PAPERS

At the workshop, the five workgroups developed quantitative estimates of supply, demand and need in the environmental health specialties to which they were assigned. The groups defined the specialty areas, discussed the factors which influenced the work force, suggested methods by which existing data gaps might be closed, and made recommendations for preparing an adequate work force. The academician specialty was analyzed after the workshop was concluded using the data provided by the five workgroups to determine how many academicians are required to educate the numbers needed in the various specialty areas. Summaries of the position papers are presented below. Complete texts are available on request. Tapes of some of the discussions are also available.

The process used by the groups in making the estimates was as follows. The first step was to examine all existing sources of data. These included published reports and articles, data from professional associations and pertinent information from unpublished sources. A compilation of these data was made available to all participants prior to the workshop. Another important resource, also distributed to the participants prior to the workshop, were the commissioned papers. Using data from these materials as points of departure, each group utilized the knowledge and judgment of its members to determine the estimates of supply, demand and needs in its assigned specialties. No specific format was imposed for conducting the group sessions. The process used was essentially one of arriving at consensus through informed discussion. A suggested outline of the position papers and a glossary of terms helped to achieve consistency and comparability of estimates.

Documentation of how the numerical estimates shown in Exhibits 1.1, 1.2 and 1.3, (pages 21, 22, and 23) were arrived at is contained in the background and position papers. As has been described, these estimates are the results of lengthy deliberations by groups of experts whose goal was to determine the most accurate numbers possible based on available data and on carefully applied knowledge and judgment. The estimates will help fill an important data gap. Until definitive surveys are undertaken they will provide the most comprehensive and timely estimates available on the environmental health work force.

5.1 AIR AND WATER

In developing its estimates of the work force in Air and Water, this group included individuals whose employment, educational background or job function is in environmental health, as defined in Chapter 1 of this report. It looked at the following personnel categories: scientist, engineer, specialist, operator, and technician, and other. The scientist, engineer and specialist categories and a portion of the other category can be considered professional. The specialty areas of air quality, water supply, and wastewater were considered separately.

Air quality personnel are responsible for maintaining a level of air quality that ensures the health, welfare, comfort and convenience of the community. Based on data presented in the background papers and other material, the group estimated that the 1987 supply of practitioners in air quality included approximately 1,575 scientists, 5,200 engineers, 10,150 specialists, 10,150 technicians, and 1,000 other practitioners. These estimates total 27,925. The group determined that 1987 demand equaled supply. The 1987 need was estimated to be only slightly higher, 28,350, with the difference accounted for by individuals who would address the problems of acid rain, acid disposition, toxics and indoor air pollution. Estimates for 1992 were based on a projected five percent increase in 1987 demand, supply and need yielding totals of 29,321 for supply and demand and 29,767 for need.

Practitioners in noise control develop and implement programs to prevent loss of hearing, minimize the psychological effects of noise, and reduce the nuisance associated with noise. Although personnel in this area are highly specialized, the group felt that their supply and demand was low. Due to the lack of available data, the group was unable to estimate current or future supply, demand and need in this area. It did note, however, that this area was essential and must not be neglected.

Environmental health practitioners specializing in water supply work to supply safe and acceptable water to the community to prevent disease. The group estimated that the 1987 supply in this area was 186,000 including 5,000 scientists, 22,500 engineers, 4,500 specialists, 84,000 operators, 60,000 technicians, and 10,000 others. Demand in 1987 was estimated to equal supply. The group felt that a total of 192,500 personnel was needed, including individuals to monitor chemicals in the new water standard and additional scientists to improve the understanding of factors essential to water quality maintenance. For 1992, supply and demand were both projected to be 195,300, with need at 202,125. These values are five percent above the 1987 levels.

Personnel in the wastewater area are responsible for controlling water pollution from municipal and industrial sources.

The 1987 estimated supply of practitioners in this field includes 5,800 scientists, 17,000 engineers, 12,000 specialists, 85,000 operators, 90,000 technicians and 10,000 others for a total of 219,800. Again, it was determined that demand equaled supply. The group felt that an increased number of operators and technicians were needed and estimated the 1987 need to be 235,000. Estimates for 1992 were based on a five percent increase and were 230,790 for supply and demand and 246,750 for need.

This group felt that training of personnel at all degree levels, continuing education programs, self-teaching and extension courses, and the retraining of personnel in the new and emerging areas of public health were imperative. It recommended that Federal funding support these educational programs.

5.2 MILK AND FOOD PROTECTION AND INSTITUTIONAL SAFETY & HEALTH

Milk and food protection programs assure that food (including milk) and food products are safe, wholesome and sanitary at all stages: production, processing, distribution, transportation, and service. The majority of practitioners in the field are employed by state and local health departments. Others are associated with Federal regulators, food manufacturers, food processors and distributors, warehouses, restaurants, and institutional establishments. Most practitioners are sanitarians; a baccalaureate degree is usually required for entry to the field.

Problems in determining the supply of and demand and need for personnel in this area resulted from sanitarians in local health departments being likely to work in a variety of areas. In addition, the variety of job titles used made it difficult to estimate the numbers working in industry. Despite these factors, the group estimated that supply and demand were balanced in 1987 at 14,000 practitioners. An additional 7,000 personnel were felt to be needed to achieve optimal levels of protection of the food supply. For 1992, the group estimated that supply and demand would be equal at 17,500 and that need would increase to 24,000.

This group felt that there were education and training inadequacies in the areas of foodborne illness sources, food crisis management, food processor inspection, milk protection, and monitoring imported food. Emerging problems are irradiated foods, new pathogens, and new technologically sophisticated production and processing methods. These problems will result in a need for an increased number of personnel, improved training programs, improved interagency cooperation, and increased industry responsibility and accountability. Inadequate salaries, particularly at state/local health departments, are also a problem.

State and local program budgets are not likely to increase to meet these national needs, therefore Federal support may be necessary. An alternative source of funding is "fee for service" licensing. In order to meet the training needs of the work force, the group recommended the establishment of a National Food Protection Academy to provide both apprentice and journeyman level technical training, the establishment of a national registration program for all environmental health disciplines, a certification specialty in milk and food protection and other specialty areas, and mandatory continuing education. Government, industry and professional associations must work together to meet these needs. A periodic survey by a recognized organization such as the National Environmental Health Association would best measure the work force in environmental health.

The group define **institutional safety and health** as the control of biological, physical and chemical factors which affect man's health and degrade the quality of life in the institutional setting. Practitioners, including managers, scientists and sanitarians, are responsible for a wide variety of activities including food, air, water, radiation, infection, occupational health, safety, waste management, and public education. Professionals should hold a bachelor's degree in environmental health and a master's degree in environmental health or public health.

Estimates of supply, demand and need were developed by determining the number of practitioners in each of the following institutional settings: hospitals, nursing homes, two-and four-year universities, K-12 school systems, Federal and state detention facilities, and county jails. The 1987 supply was estimated to be 18,250 personnel and a demand for 19,115. The need was determined to be 29,550. Increases in demand and need for these personnel are expected due to increasing liability, changing technology, expanding public awareness, new legislation and required certifications. By 1992, the supply of personnel was predicted to decrease to 12,175 because fear of AIDS will inhibit some individuals from entering the field. Demand in that year was estimated to be 28,060 with a need for 45,450 personnel.

The group recommended that (1) a role delineation model and core curriculum be developed for training institutional environmental health professionals; (2) a model of a comprehensive institutional program be developed; (3) congruency between undergraduate and graduate educational programs be established; and, (4) academic institutions be encouraged to expand existing programs at all levels and to develop new programs.

5.3 HAZARDOUS MATERIALS MANAGEMENT AND ENVIRONMENTAL EPIDEMIOLOGY/ENVIRONMENTAL TOXICOLOGY/RISK ASSESSMENT

This group first defined each field and then estimated the supply, demand and need for each. Hazardous materials managers are those professionals involved in the control and management of hazardous wastes.Environmental epidemiologists develop, implement and evaluate environmental epidemiological investigations, with an emphasis on the use of methodological and mathematical tools to assist in the identification of the causes of disease. Environmental toxicologists determine the adverse health effects and the mechanisms of those effects resulting from exposure to agents in the environment. Risk assessors use available information to evaluate and estimate the probability and likely consequences of exposure to a substance through a process involving hazard communication, exposure assessment, dose-response assessment, and risk characterization.

The 1987 supply of hazardous materials management professionals was estimated to be 50,000. As is true of all numbers in this category, these are individuals not FTEs. As the demand was determined to be 55,000, a large shortage was estimated for the field. Need, at 75,000 individuals, results in an even larger shortage. The situation was not expected to improve by 1992. Supply in that year was estimated to be 75,000 practitioners with a demand for 85,000 and need for 100,000. These figures were based on the current numbers of large and small hazardous materials generators. Needs in this field are particularly acute because of the diversity of skills required and the need for all professionals to maintain a high level of competence.

The group estimated that there are currently 500 environmental epidemiologists, a demand for 600, and a need for 700. By 1992, the supply is expected to increase to 750. However, demand and need are also predicted to increase to 800 and 1,000, respectively.

The 1987 supply of environmental toxicologists was estimated to be 3,000. One third of these practitioners are in basic research and the remainder are in applied toxicology. Demand, at 3,600 practitioners, and need at 4,000, both exceed the supply in this field. By 1992 the shortage was predicted to increase, with supply at 3,500, demand at 4,500 and need at 6,500. The group felt that the current National Institute of Environmental Health Sciences training programs could be expanded to meet the needs in both epidemiology and research toxicology; however, new programs would be needed to increase the number of applied toxicologists.

The group did not estimate the work force in risk assessment for the following reasons: (1) it was felt that risk assessments were currently being conducted by epidemiologists and toxicologists; (2) there was disagreement concerning whether risk assessment would become a specialty area or an activity; (3) qualifications for individuals in this area have not been established; and, (4) there is little training for individuals in this field.

In general, this group felt that government has failed to provide the leadership for effective program management in environmental health. In addition, current educational and training resources are insufficient to ensure a competent work force. The group also stated that sufficient data on the work force has been collected and government should now move to providing proper hazardous waste training. To rectify these problems, it was recommended that the Public Health Service be responsible for seeing that the necessary training and education is provided and that it work with the Environmental Protection Agency and other Federal agencies to develop a national plan to develop a competent work force in hazardous materials management.

5.4 OCCUPATIONAL SAFETY & HEALTH AND RADIOLOGICAL HEALTH

The field of occupational safety and health is comprised of four major areas: industrial hygiene, occupational medicine, occupational health nursing, and occupational safety. The primary emphasis of practitioners in these categories is on the management of hazards in the workplace. The group first defined qualitative criteria based on certification by appropriate organizations, education and experience. These were considered to be the desirable qualifications, although individuals currently practicing in the field may not meet them.

Based on estimates by the Bureau of Health Professions, the 1987 supply of industrial hygienists was determined to be 11,000 individuals. The group felt that there was no surplus or shortage of practitioners in this area, so demand equaled supply. Need was estimated to exceed demand by 25 percent, for a total of 13,750 individuals. Assuming that undergraduate and graduate programs graduate 500 students per year over and above the number required to replace retirees, the 1992 supply was projected to be 13,500. The historical growth rate in industrial hygiene, as determined by the National Institute for Occupational Safety and Health (NIOSH), would set demand at 15,000 by 1992. Need would again exceed demand by 25 percent, or 18,750 practitioners.

The supply of occupational safety practitioners in 1987 was estimated to be 43,690 based on a 1977 survey by NIOSH. The group felt that both demand and need in this area equaled supply and that no or little growth was expected (based on the results of a 1985 NIOSH study). Therefore, in 1992 supply, demand and need would again be equal at 45,920 practitioners, assuming a one percent growth rate per annum.

The 1987 supply of qualified occupational health nurses was determined to be 10,800 individuals using the results of a 1985 study by Christensen while the total supply (qualified and unqualified) was 29,000. Thus 18,000 nurses are estimated to need additional training. Demand and need were estimated to be 29,000 based on 1980 estimates by the Department of Health and Human Services (DHHS) and 1987 figures of the Bureau of Health Professions (USPHS). Data from NIOSH indicates that growth in this field will be approximately 3.2 percent per year, thus the 1992 supply is expected to increase to 12,643 individuals. Demand and need were estimated to rise to 34,440 practitioners, assuming the 3.5 percent annual growth rate determined by NIOSH in 1978.

The group had difficulty determining the supply, demand and need for occupational health physicians because the majority of practitioners are not board eligible or certified. In addition, many practitioners do not consider occupational health to be their primary specialty and are not employees of an institution. BHPr estimated the 1987 supply of occupational physicians to be 3,000 based on self-reported data from AMA. However, only a small portion are board certified. The Graduate Medical Education National Advisory Committee (GMENAC) projected the 1990 need to be 2,300 board certified practitioners. The group used BHPr's figures for the 1987 demand and need because they felt that the demand and need for personnel in this field has increased since 1985 and will continue to increase at a rate of at least ten percent each year. The 1987 supply was determined to be 1,200 practitioners based on the number of board certified and board eligible physicians. The group assumed a net gain of 50 physicians per year so that the 1992 supply would be 1,550. Based on a ten percent growth rate, 1992 demand and need were estimated to be 4,830.

The group felt that shortages in these areas could be attributed to a lack of Federal funding, the lack of paid residencies or internships, and the lack of industry payment for training. In order to balance the supply of and demand for practitioners, the group recommended increased public and private funding, greater utilization of research dollars for graduate students and training, increased funding of professional training by the states, and an increased number of professional programs. In addition, they felt that a higher priority should be placed on training and education, particularly at the graduate level.

In order to address the data gaps in occupational safety and health, the group felt it was imperative for each of the four categories to identify and delineate the requirements of its profession. After so doing, professional associations could collect data on their memberships or Federal agencies could provide funding for a national survey.

The field of **radiological health** includes two primary professional categories, health physicists and radiation protection technologists. Both are educated in the physical sciences. However, radiation protection technologists have a relatively limited scope of work and authority concerning complex radiological issues. The 1987 supply of health physicists was estimated to be approximately 7,900 based on data from the 1981 Symposium of the National Council on Radiation Protection Measurements. Demand

and need for 1987 were estimated to be 9,400 according to the Department of Labor. In 1973, the American College of Radiology and the American Association of Physicists in Medicine projected a growth rate of seven percent per year. Using this figure, the group determined that 1992 supply, demand and need for health physicists would be 11,130, 13,180 and 13,180 respectively.

The 1987 supply of radiation protection technologists, based on the membership of professional associations and the staffing of major employers, was estimated to be 2,000. Current demand and need were determined to be 3,000 based on a 50 percent increase in need and understaffed positions in the areas of indoor air quality (radon) and medical radiological health. Estimates for 1992 were based on the 7 percent growth rate used for health physicists. The supply would increase to 2,800 practitioners, while demand and need would both increase to 4,200.

The group attributed the shortages in radiological health personnel to the significant curtailment of Federal support for education at the graduate level, the reduced level of construction of nuclear power plants, and a growing skepticism on the part of citizens toward the nuclear industry. Recommendations to address these problems focused on Federal or industry support of formal education and training programs, particularly at the graduate level.

5.5 LAND USE PLANNING & MANAGEMENT AND SOLID WASTE MANAGEMENT, HOUSING, VECTOR CONTROL AND NONWORKPLACE INJURY CONTROL

Land use planning and management involves the review of land use proposals to assess environmental impacts and evaluate health risks and the recommendation of actions to ensure the health and safety of the public, as well as to protect the environment from degradation. Professionals in the area include environmental health practitioners, engineers and planners. Determination of the supply of professionals in this field in 1987 was based on estimates of the work force in California and extrapolated to the U.S. as a whole. This resulted in an estimated supply of 3,000 to 5,000 practitioners. Based on the group's knowledge and expertise, demand and need were both estimated to be between 3,300 and 5,500 individuals. By 1992, the supply was predicted to increase to 3,500 - 6,000 with demand and need both rising to 4,000 to 6,000 professionals. The group felt that legislation, regulation, and increased public awareness could affect future supply and demand in this field.

Recommendations in this area included: (1) linking the National Environmental Health Association, the Association of Environmental Professionals and the American Planning Association to continue to study this area; (2) establishing a national clearinghouse for the collection of work force data; and, (3) developing a credentialing mechanism. The group also felt that university programs should include experience and practical methods courses in the curriculum and that additional courses on national and state policies be added.

In each of the "other" areas, demand figures were developed based on estimates of the work force in five states extrapolated to the nation as a whole. The Federal work force was then added. Supply and need were developed based on the knowledge and experience of group members. For **solid waste management**, the 1987 demand was estimated to be 3,500 professionals and 8,000 technicians. It was felt that there was a shortage of professionals in this area (supply of 2,000) and a surplus of technicians (supply of 9,000). In order to develop a qualified work force in the area, the group felt that 7,000 professionals and 4,500 technicians were needed. The 1992 demand was estimated to equal the 1987 need. Need in that year would remain constant and would equal demand. There would still be a shortage of professionals (supply of 4,000) and a surplus of technicians (supply of 6,000). The group recommended that continuing education opportunities be expanded to update technicians in the current work force so that they might help meet the demand for professionals. It also felt that individuals with knowledge of chemistry, biology and engineering, as well as toxicology and epidemiology would be in great demand.

In the field of **housing**, the 1987 demand was estimated to be 4,000 professionals and 8,000 technicians. As in solid waste management, the group perceived a shortage of professionals (supply of 2,000) and a surplus of technicians (supply of 12,000). The need was determined to be for 9,000 professionals and 3,000 technicians. By 1992 both demand and need were expected to equal the 1987 need of 9,000 professionals and 3,000 technicians. The total number of practitioners was expected to increase by 1992, although there would still be imbalances. The supply of professionals was predicted to be 4,000 while that of technicians remained at 12,000. Specific to this area, Group 3 suggested that competition for declining resources among programs at the local level could result in a slight decrease in the size of the work force. However, new concerns such as indoor air pollution and other toxics would increase the future need for individuals with training in toxicology and epidemiology. Backgrounds in industrial hygiene will also be sought.

The 1987 demand for professionals in the area of **vector control** was estimated to be 6,000, while that for technicians was 20,000. The supply was estimated to be [illegible],000 professionals and 30,000 technicians. The 1987 need was for 10,000 professionals and 16,000 technicians. The 1992 demand was estimated to equal 1987 need. The supply of professionals was predicted to increase to 4,000 while the number of technicians would remain constant at 30,000. The 1992 need would be for 13,000 individuals in each category. The group recommended that the training of technicians be increased to elevate them to the professional level in order to meet the needs of the field. It also suggested that the use of toxic chemicals in the control of vectors will require that individuals have more knowledge of chemistry, toxicology and epidemiology.

Injuries were defined by the group to be unintentional, non-occupational and non-motor vehicle accidents. Current demand in the injury control field was estimated to be 900 professionals and 2,000 technicians. Again, the group felt that there was a shortage of professionals (supply of 400) and an overabundance of technicians (supply of 4,000). The need estimates reveal a requirement for a large number of professionals (6,300) and few technicians (800). By 1992, the demand for professionals was expected to increase to 1,500 individuals while technician demand remained constant. Because few injury control programs now exist, supply and need were not expected to change by 1992. The group felt that this was a high priority area which must be viewed as a major nationwide health problem. They recommended that (1) local epidemiologic studies be conducted to determine local injury problems; and, (2) the Federal government support the collection and analysis of state and local morbidity data, as well as the implementation of local injury control programs.

The group made several recommendations applicable to all areas. These included: (1) provide funds, possibly from the transfer of local service monies, to upgrade the knowledge and skills of individuals now in technical positions; (2) increase support of training by the Federal government, possibly through the Superfund program; (3) encourage employers of environmental health professionals to employ graduates of environmental health programs; and (4) develop an effective, affordable and accessible continuing education system. In order to fill the data gaps related to the qualifications of practitioners and educational opportunities, Federal funding (possibly obtained from the transfer of funds from Superfund) should be provided to support a survey of the current work force.

5.6 ACADEMICIANS

During the workshop it was decided that a position paper on Academicians would be prepared after the workshop was concluded by the faculty participants. This paper would evaluate the position papers prepared by the five workgrups and determine the estimates of the academician supply, demand and need based on the estimates determined by the workgroups for the various environmental health work force specialties.

An environmental health academician is defined as an individual qualified by education and practice to teach the principles and concepts of environmental health in either a graduate or undergraduate program; to conduct research on the fundamental relationships of the physical, chemical and biological processes that impact the environment and subsequently human health; and to serve as a community resource for addressing environmental issues.

Professors of environmental health may be professionals educated either in environmental health or in a field that contributes to the interdisciplinary nature of environmental health, such as: the physical, biological and chemical sciences, health sciences, engineering, social and behavioral sciences, administration, policy and planning. Approximately 70 percent of graduate faculty and 85 percent of undergraduate faculty in environmental health were educated in a discipline other than environmental health. The majority of environmental health faculty (65 - 75 percent) hold a doctoral degree. Faculty without doctorates are slowly being replaced by new individuals holding doctorates.

A total of 2,065 academicians were estimated as composing the current supply. By 1992 this number would increase to 2,170. The 1987 need for academicians is 2,275, 210 greater than the supply. In 1992 the need was projected to be 2,629, exceeding the supply by 459. The reasons for the growth in disparity between need and supply from 1987 to 1992 include the length of time required to produce a new doctoral graduate, the competition from industry for doctoral graduates, and the additional experience required by new doctoral graduates to become effective teachers.

Recommendations by the faculty participants for addressing increased needs for academicians included: 1) The creation of new teaching programs, and 2) Providing incentives for new professors, including fellowships covering tuition and stipends, active research programs in universities, cooperative programs between government and industry, cooperative arrangements between appropriate undergraduate departments and graduate environmental health programs, and non-traditional programs to assist part-time studies. Retired environmental health scientists and engineers seeking second careers were suggested as potential academicians.

Faculty participants believed that an adequate supply of academicians is essential to meet needs for qualified personnel in all the various environmental health specialties. A very high priority must be placed on securing and maintaining the supply of this critical component of the work force. Although relatively small in numbers, the environmental health faculty has a profound impact on the status of the total work force.

6. CLOSING REMARKS

Final words were provided by Larry Gordon in his **closing remarks** to workshop participants.

It is regrettable that we have so much difficulty in developing needed data. If data are not readily available, problems cannot be defined nor can they be solved. The workshop has provided data that should be very illuminating and useful.

This has been a most productive meeting. The data developed by the workgroups are the best available and they have substantial validity. However, there may be a question about the comparability of the data. Some groups have chosen to take in a wider universe of·the environmental health work force than did others, although each group has clearly defined the universe within its report. For the professional work force, the data are readily extractable, by separating out the technicians, for example. The water quality workgroup took in all the sewage treatment plant and water plant operators. These data can be adjusted for comparison with the solid waste data (which did not take in all the land-fill operators) or the food protection estimates (which did not include all the food service managers and managers of food plants). To obtain uniformity of interpretation some data manipulation and explanation will be necessary to avoid comparing apples and oranges and to assure that there is an intelligent basis for discussion.

It is unfortunate that representatives of the Environmental Protection Agency were unable to attend this workshop. EPA is a health agency; every one of its programs is a health program. It was through the efforts of the public health people that the EPA was created. The Muskie report of the late 1960s which preceded President Nixon's creation of the EPA by executive order, complained that the Public Health Service (specifically, the Consumer Protection and Environmental Health Service of the PHS) was doing what legislators and the general public perceived as too much research and was not engaged in enough action. State after state got their present configuration, to a significant degree, by default or abdication that took those programs out of the public health umbrella. Nevertheless they were public health programs then and they still are today. About a dozen states have a Department of Environmental Protection or Environmental

Quality Council or a Bureau of Environmental Health in the health department. In the interests of establishing communications the director of each state EPA -- and there are some 30 of them -- should be contacted as a primary health official of the state. Their programs are just as much health as are the so-called personal health programs. Perhaps one way to promote closer relationships is to make whatever efforts we can to subsume them instead of building barriers.

The data that have been produced by this workshop are interesting and they are as valid as we can make them. They should be very useful to the Bureau of Health Professions which funded the workshop as well as to people and agencies throughout the nation who are concerned with protecting and promoting the health of our citizens.

APPENDIX

EVALUATING THE ENVIRONMENTAL HEALTH WORKFORCE

July 13 - 16, 1987

CONFERENCE AGENDA

Monday, July 13, 1987

4:00 - 6:00 p.m. Registration
Foxes Den

6:00 - 6:50 p.m. Reception

7:00 - 7:50 p.m. Dinner

8:00 - 8:40 p.m. Overview of the Conference
Meadow Room

Eugene Levine
Project Director, Evaluating the Environmental Health Workforce
Levine Associates, Inc.

Faye G. Abdellah
Deputy Surgeon General, USPHS

William A. Robinson
Chief Medical Officer
Health Resources and Services Administration

Thomas D. Hatch
Director
Bureau of Health Professions, HRSA

8:40 - 9:10 p.m. Opening Address:
"Evaluating the Environmental Health Workforce"
Larry J. Gordon
Secretary for Health and Environment
State of New Mexico

9:10 - 9:20 p.m. Question and Answer Period

9:20 - 9:30 p.m. Closing Remarks and Adjournment

Tuesday, July 14, 1987

7:15 - 8:00 a.m.	Breakfast
8:00 - 8:10 a.m.	Opening Remarks Meadow Room Presentation of Commissioned Papers: "Workforce Status and Outlook for Environmental Health Professionals"
8:10 - 8:20 a.m.	I. Air Ray Mohr Air Pollution Control Division Colorado Department of Health
8:20 - 8:30 a.m.	II. Water John Conway San Diego State University San Diego, California
8:30 - 8:50 a.m.	Questions and Answers: related to Papers I - II.
8:50 - 9:00 a.m.	III. Milk/Food C. Dee Clingman Vice President, Director, Quality Control Red Lobster Restaurants, Orlando, Florida
9:00 - 9:10 a.m.	IV. Institutional Safety and Health Joe Beck Western Carolina University Cullowhee, North Carolina
9:10 - 9:30 a.m.	Questions and Answers: related to Papers III - IV.
9:30 - 9:40 a.m.	V. Hazardous Materials Management Richard Wade Strategic Organizational Systems International San Francisco, California
9:40 - 9:50 a.m.	VI. Epidemiology/Toxicology/Risk Assessment Christopher Schonwalder National Institute for Environmental Health Sciences
9:50 - 10:10 p.m.	Questions and Answers: Related to Papers V - VI.
10:10 - 10:30 a.m.	Break

Tuesday, July 14, 1987

10:30 - 10:40 a.m.	VII. Radiological Health Harold Lehman Center for Devices and Radiological Health, FDA
10:40 - 10:50 a.m.	VIII. Occupational Safety and Health David Fraser University of North Carolina School of Public Health, Chapel Hill, North Carolina
10:50 - 11:10 a.m.	Questions and Answers: related to Papers VII - VIII.
11:10 - 11:20 a.m.	IX. Other Areas George Kupfer Bureau of Consumer Protection and Environmental Health, Milwaukee, Wisconsin
11:20 - 11:30 a.m.	X. Land Use Planning and Management Richard Roberts Director, Environmental Health Services County of San Bernardino, California
11:30 - 11:50 a.m.	Questions and Answers: related to Papers IX - X.
11:50 - 12:10 p.m.	XI. Academicians Amer El-Ahraf California State University, San Bernardino San Bernardino, California Trenton Davis East Carolina University Greenville, North Carolina Anne Anderson Tulane University School of Public Health and Tropical Medicine, New Orleans, Louisiana Gary Silverman Bowling Green State University Bowling Green, Ohio
12:10 - 12:20 p.m.	Questions and Answers: related to Paper XI.
12:30 - 1:40 p.m.	Lunch
1:45 - 2:30 p.m.	Charge to Workgroups Meadow Room Eugene Levine
2:30 - 5:30 p.m.	Workgroup Sessions

7:00 p.m. -	Dinner Cookout

Wednesday, July 15, 1987

7:15 - 8:00 a.m.	Breakfast
8:00 - 11:30 a.m.	Workgroup Sessions
11:30 - 12:30 p.m.	General Session Meadow Room Reports from Workgroups
12:30 - 1:50 p.m.	Lunch
2:00 - 5:00 p.m.	Workgroup Sessions
6:30 p.m. -	Dinner

Thursday, July 16, 1987

7:15 - 8:00 a.m.	Breakfast
	General Session - Reports from Workgroups and Discussion
8:00 - 8:30 a.m.	Group I: Air and Water
8:30 - 9:00 a.m.	Group II: Milk/Food and Institutional Safety and Health
9:00 - 9:30 a.m.	Group III: Hazardous Materials Management and Epidemiology/Toxicology/Risk Assessment
9:30 - 10:00 a.m.	Group IV: Radiological Health and Occuaptional Safety and Health
10:00 - 10:30 a.m.	Group V: Other Areas and Land Use Planning and Management
10:30 - 10:45 a.m.	Break
10:45 - 11:45 a.m.	Summary and Closing Larry J. Gordon Eugene Levine
12:00 - 1:00 p.m.	Lunch
1:00 p.m. -	Departure from Airlie House

LIST OF CONFERENCE PARTICIPANTS

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EVALUATING THE ENVIRONMENTAL HEALTH WORKFORCE
July 13 - 16, 1987

GUIDE TO WORKGROUP SESSIONS

Conference participants will be assigned to one of five workgroups which are divided into the following occupational specialties.

Group I	Air; Water
Group II	Milk and Food; Institutional Safety and Health
Group III	Hazardous Materials Management; Epidemiology/Toxicology/Risk Assessment
Group IV	Radiological Health; Occupational Safety and Health
Group V	Land Use Planning and Management; Other Areas

There will be three workgroup sessions:

Tuesday, July 14: 2:30 P.M. - 5:30 P.M.
Wednesday July 15: 8:00 A.M. - 11:30 A.M.
Wednesday July 15: 2:00 P.M. - 5:00 P.M.

There will be two general sessions for presentation of workgroup reports:

Wednesday, July 15: 11:30 A.M. - 2:30 P.M.
Thursday, July 16: 8:00 A.M. - 10:30 A.M.

Workgroup assignments are contained in Enclosure 3. You will note that academicians in environmental health will not be dealth with by a separate workgroup. Each workgroup will give consideration to academicians as related to its own specialty areas. A special workgroup will be convened on Wednesday evening to consider academician supply/demand/needs with input from the other workgroups.

Workgroups will be chaired by a workgroup leader. A workgroup reporter will be selected from the group to give reports at general sessions. A recorder from Levine Associates' staff will be assigned to each group to tape record all workgroup sessions. Larry Gordon, Barry Stern and others will circulate from group to group to answer questions and clarify issues as needed. Questions can also be addressed to authors of commissioned papers who, although assigned to specific workgroups, will be available to respond to questions from other groups.

A major objective of the workgroups is to arrive at a quantitative estimate of the supply, demand and need in the occupational specialities considered by the workgroup. Enclosure 6 contains the table shell that each group is expected to complete by the end of the workshop deliberations on Wednesday evening for each of their specialties. These data will be shared with all participants in the closing general session on Thursday morning. In making these estimates the group will use: (1)the material in commissioned papers; (2)the background material prepared by Levine Associates' staff; (3)other data that will be brought to the Conference by participants; and (4)participants' own knowledge and judgment . For many specialties these estimates will result from "educated guesses" of the group and this will be indicated in the workgroup reports to help guide future uses of the data.

In addition to determining the quantitative estimates, the workgroups will consider the factors that impact on supply, demand and needs in their specialties, areas of greatest shortages and ways of meeting shortages. The workgroups should also develop a data collection methodology plan for obtaining more definitive information on their specialties.

Thus, while a specific agenda is not provided for the workgroup sessions it is expected that the following topics will be discussed by each group and included in the final report of the group to be presented at the general session on Thursday morning.

1. Definition of environmental health workforce with particular reference to the specialties considered by the workgroup.

2. Current and future status of supply/demand/needs in the various specialty areas.

3. Factors impacting on supply/demand/needs, currently and in the future.

4. Meeting the demand/needs for environmental health personnel.

5. Setting priorities for an adequate workforce.

6. A plan for collection of data on the environmental health workforce.

Within this framework of topics, the manner and pace with which each topic will be discussed will determined by the group. To help guide workgroup discussions the following pages present a description of these six topics and contain suggested questions that could be addressed by participants in their discussions. This material is presented with recognition that each workgroup may not be able to adequately cover each topic in the time allotted. Each group is free to pursue the discussion of its assigned specialty areas in the manner that it sees fit. The one topic that must be addressed by all workgroups is the quantitative estimate of supply, demand and need. The final report of each group, to be presented at the general session on Thursday morning, should use the following outline:

1. Background
2. Estimates of supply/demand/needs
3. Recommendations for addressing shortages
4. Methodology for filling data gaps

1. Definition of Environmental Health Workforce

Discussion of this topic will attempt to arrive at a workable definition of the environmental health workforce. Conceptually what is the most desirable categorization of areas, specialties and work settings for measurement purposes, to determine educational programs, and for planning? Each workgroup should clearly define the occupational specialties for which it is responsible.

2. Current and Future Status of Supply/Demand/Needs.

The focus of this topic is on the assessment, quantitatively, of the supply/demand/needs in each specialty. The group will collate data from the commissioned papers and make an appraisal of the overall situation, using the table shell in Enclosure 6. The precision of each estimate (or lack thereof) should be indicated in the reports from each workgroup.

3. Factors Impacting on Supply/Demand/Needs, Currently and in the Future.

The focus of this discussion topic is to explore the important factors that are impacting on the environmental health workforce supply, demand and needs, both today and in the next five years. Recommendations arising from consideration of this topic should consider the need for assessing the impact of these factors in planning to meet the needs of the various specialty areas. In formulating these recommendations, the group might consider the following issues and questions:

- What environmental health problems are currently being addressed -- adequately? inadequately?
- What are the important environmental health problems that will impact on workforce supply/demand/needs in the next five years.
- How will problems be translated into programs?

- What programs are likely to be supported to meet these problems?
- Where will the support for programs come from -- Federal government, state and local government, private industry?
- Where will government and industry receive its workforce - fresh out of schools, re-training.
- Is the current workforce prepared to meet future identified needs? If not, why not? How can they become ready?

4. Meeting the Demand/Needs for Environmental Health Personnel

In this topic the group will assess existing educational programs and other programs that impact on supply/demand/needs of the specialty areas assigned to the group. Recommendations should be directed at ways in which educational and other programs can enhance the supply, both quantitatively and qualitatively. Issues and questions to be considered are:

- Are we meeting the demand for environmental health personnel?
- Delineation of competencies, skills and functions in the environmental health workforce.
- Roles of schools of public health and undergraduate and graduate programs outside schools of public health in providing educational preparation.
- Coordination between education and training in environmental health and requirements of the workplace.
- Non-academic approaches to enhancing the supply of environmental health personnel.
- Roles of government and private industry in providing financial support for enhancing the workforce supply.
- Maintaining standards of quality of the workforce -- credentialing in environmental health.
- Substitution of personnel in meeting demand.
- Expandibility of the environmental health professions training establishment -- lead times, sources of faculty, in-service training as a substitute for degree programs, etc.

- How can we effectively educate people quickly to meet the demand.

5. Setting Priorities for an Adequate Environmental Health Workforce: Quantitative and Qualitative.

This discussion will delineate areas of greatest need in the environmental health workforce. It should view the workforce wholistically, determining possible tradeoffs among different areas and specialties. Issues and questions include:

- Can the environmental health workforce be viewed as a relatively well-defined, homogenous group?
- What are the consequences of a significant shortage in an area or specialty?
- What are cost-effective approaches to alleviating shortages?
- What is a realistic time-table to provide solutions to workforce problems?
- What are the roles of government, private industry, and professional associations in alleviating shortages?

6. A plan for Collection of Data on the Environmental Health Workforce.

The objective of this topic is for each group to determine appropriate methodology for filling data gaps in their specialty areas. The following questions and issues can help guide the discussion of this topic.

- How can we accurately measure the environmental health workforce?
- What are cost-effective approaches to measuring the workforce.
- Collection, uses, and dissemination of data. Who is responsible for what?
- Relationship of environmental health workforce data and data on other health personnel.
- Establishment of a data retrieval system to obtain data on the workforce. Who should be responsible for such a system? What is a realistic timetable for the development of such a system?

EVALUATING THE ENVIRONMENTAL HEALTH WORK FORCE
DEFINITIONS OF KEY TERMS

A. GENERAL TERMS

Accreditation: The process by which an agency or organization evaluates a program of study, or an institution, as meeting certain predetermined standards.

Certification: The process by which a nongovernment agency or association grants recognition to persons meeting predetermined qualifications specified by that agency or association.

Credentialing: The recognition of professional or technical competence by the federal or state government, private professional groups, and certifying organizations.

Demand: The number of funded positions in a given occupation, whether filled or unfilled.

Environmental Health: The systematic development, promotion, and conduct of measures which modify or otherwise control those external factors in the indoor and outdoor environment which might cause illness, disability or discomfort through interaction with the human system. This includes not only health and safety factors, but also aesthetically desirable conditions in accordance with community demands and expectations.

Environmental Health Practitioner: An individual whose employment or job function in environmental health has a clear public health implication.

Environmental Health Professional: An environmental health practitioner whose educational background includes, at a minimum, a baccalaureate degree in the major components of environmental health and the basic public health sciences of epidemiology and biostatistics and whose primary focus is on protecting human health.

Licensure: The process by which a state government agency grants permission to persons meeting predetermined qualifications to engaged in a given occupation.

Need: The number of persons in a given occupation judged as required to produce a desirable level of service.

Operator: An environmental health practitioner qualified by education, training and practice to manage plant and systems processes necessary for environmental health control and prevention activities. Certification is usually required.

Other (Professional in Environmental Health): An environmental health practitioner who holds as a minimum a baccalaureate degree, but whose primary academic focus was on areas other than protecting human health (for example, geologists, engineers, biologists, physicists and chemists).

Position Vacancy: An unfilled position in a given occupation which is being recruited for.

Registration: The process by which qualified individuals are listed on an official roster maintained by a governmental or nongovernmental agency/board. Registration may also require minimum practice standards.

Shortage: Demand exceeds supply.

Supply: The number of qualified personnel available to practice a given occupation, including those employed (or self-employed) and those seeking employment in the occupation.

Surplus: Supply exceeds demand.

Technician: An environmental health practitioner qualified by education, training and practice to operate sampling, monitoring and other data-gathering equipment in the conduct of environmental health control and prevention activities. The minimum education level is specialized training.

B. SPECIALTIES

Air Quality Personnel: Environmental health practitioners responsible for assuring air quality that fosters the health, welfare, comfort and convenience of the community.

Environmental Epidemiologists: Environmental health professionals who develop, implement and evaluate environmental epidemiological investigations, including observational and experimental studies of the relationships between etiological, statistical and mathematical tools, to identify the causes of disease in human populations.

Environmental Toxicologists: Environmental health professionals who determine the adverse health effects, and the mechanisms of those effects, resulting from exposure to physical, chemical and biological aspects in the human environment.

Hazardous Materials Managers and Support Personnel: Environmental health practitioners responsible for the control and management of materials that are potentially hazardous, from the point of extraction of raw products to their elemental destruction, transformation into non-hazardous materials, or disposal in controlled facilities.

Housing Maintenance Personnel: Environmental health practitioners involved in the regulation of housing, including zoning and occupancy approvals, elimination of nuisances and regular inspection, to assure that minimum standards of health and safety are met.

Industrial Hygienists: Environmental health professionals who identify and solve potentially hazardous problems by measuring and assessing harmful chemical, physical and biological agents in the work environment.

Injury (Nonworkplace) Control: Environmental health practitioners concerned with the identification and elimination of potentially hazardous construction or conditions, and the education of the public in order to prevent unintentional, non-occupational and non-motor vehicle accidents or injuries.

Institutional Environmental Health Managers/Scientists: Environmental health professionals responsible for the control of biological, physical and chemical factors which effect the community's health and degrade the quality of life in the institutional setting.

Land Use Planners and Managers: Environmental health professionals who review land use proposals to assess environmental impacts and evaluate health risks, and recommend actions that will protect the public from exposure to disease and other health and safety hazards and will protect the environment from degradation.

Milk and Food Personnel: Environmental health practitioners concerned with the protection of the milk and food supply against contamination from biological, chemical and physical hazards from source to consumer.

Noise Control Personnel: Environmental health practitioners who prevent loss of hearing, minimize the psychological effects of noise, and reduce the nuisance factors associated with noise.

Occupational Health Nurses: Registered nurses who provide acute and rehabilitative care, and participate in preventive and health maintenance programs for workers.

Occupational Health Physicians: Physicians who conduct medical practices, diagnosis and treatment activities, direct medical departments in the workplace, and collaborate with other occupational safety and health personnel to identify, investigate and prevent the reoccurrence of occupational safety and health problems.

Occupational Safety Personnel: Environmental health practitioners who plan, develop, implement and administer injury control programs to identify and correct hazardous conditions that may cause injury to employees, damage to equipment and facilities, or loss of materials.

Radiological Health Personnel: Environmental health practitioners responsible for protecting workers and the general public from ionizing and non-ionizing radiation hazards.

Solid Waste Managers and Support Personnel: Environmental health practitioners responsible for the planning, administration and regulation of storage, transportation and disposal of solid waste.

Vector Control: Environmental health practitioners responsible for surveillance and control of rodents, insects and other vectors of public health and economic importance to prevent disease, injury, death and substantial economic loss.

Wastewater Personnel: Environmental health practitioners who control water pollution from municipal and industrial sources in order to assure water quality that fosters the health, welfare, comfort and convenience of the community.

Water Supply Personnel: Environmental health practitioners responsible for the supply of safe and acceptable water to the public to prevent disease.

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